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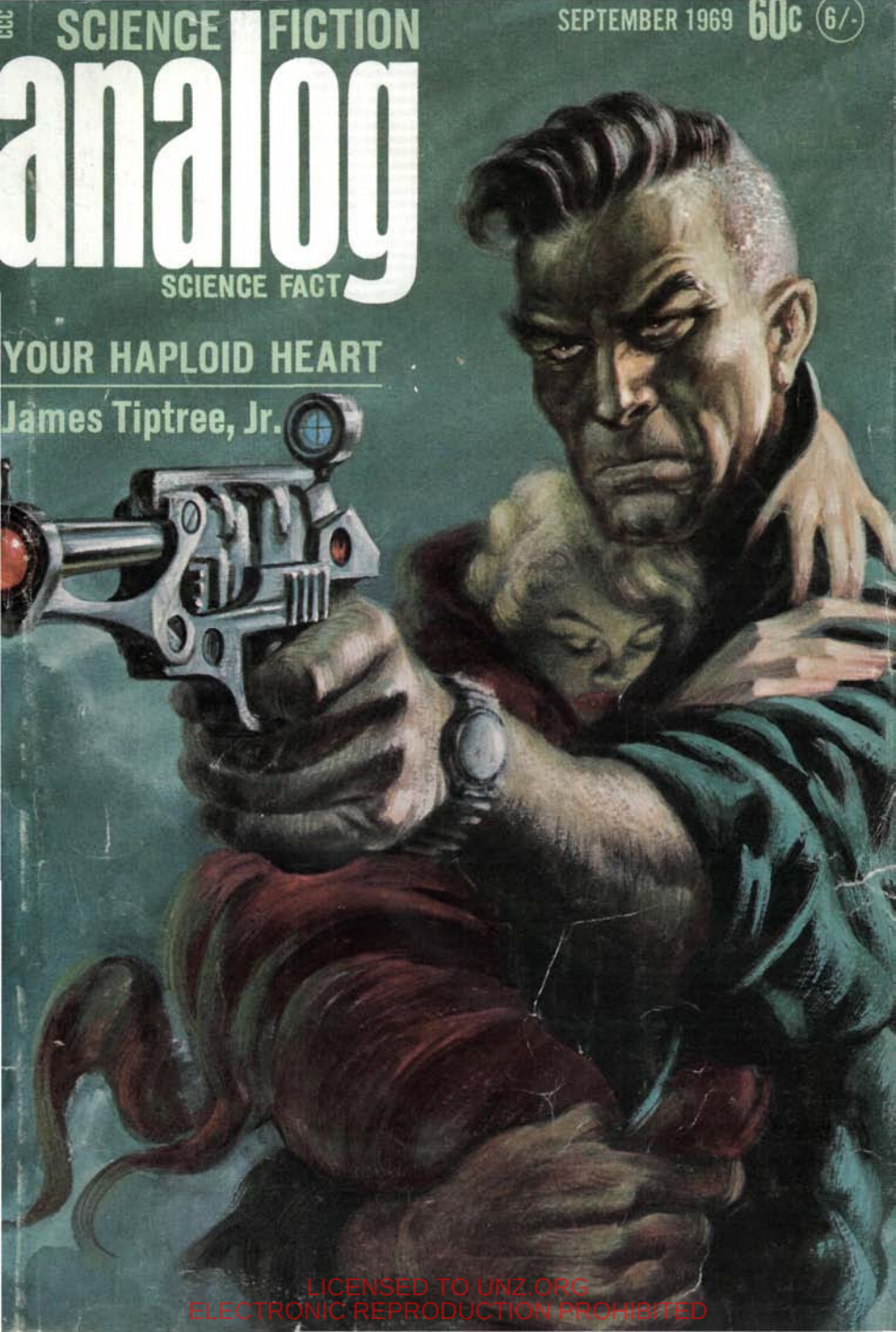
YOUR HAPLOID HEART

James Tiptree, Jr.



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The Same Old Elements

an editorial by John W. Campbell

In 1925 the last naturally-occurring stable element in Earth's mass —rhenium—was finally isolated. It wasn't that it was difficult to handle chemically—as fluorine definitely was!—but that it's an exceedingly rare element. As of 1928 the price—if you could call it a quotation!—was $10,000 per gram. As of today, the total estimated free-world reserve of rhenium is about one hundred tons—and considering the amount of free-world real estate being calculated on, that's not very much.

That date of discovery, 1925, makes an interesting dividing line in time. It's forty-four years ago; the chemical engineering students who graduated that year are just about at retirement age now——and it's worth looking at what's happened in the span of one man's active engineering career.

We'll stick to chemistry; 1932 is the Year of the Neutron, and we might have considered that—but nuclear physics added to the chemistry developments would be too lengthy a discussion!

In two respects, nuclear physics sort of overlapped into chemical engineering; the Hanford piles produced plutonium by transmutation of uranium, and some hot-shot chemical engineering was called for to separate the brand-new elements from the old-fashioned uranium and its lethally radioactive daughters. That called for developing some completely new engineering techniques—which were, naturally, presently applied in hundreds of other chemical engineering areas! Particularly, the techniques of liquid-liquid separations, and ion-exchange reactions on a large commercial scale came in for some heavy development.

The spent reactor fuel cans had to be broken down, and uranium separated from the desired product, plutonium, and from the neutron-absorbing, reactor-poisoning fission product elements. And it had to be done untouched by human hands, to a never-before achieved extent. It being a great deal easier to pump liquids around than to pick up and manipulate percipitates and ashed residues where no human being can go—all-liquid techniques were attractive.

Of course it wasn't really *necessary* to separate the mess of fission product substances from each other—just getting them out of the

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uranium, so that could be recycled for further fission reaction, was all that *had* to be done. But no chemist could have just let that unresolved mixture go without even looking into it. Naturally, new, and vastly superior methods of rare-earth element separations became necessary.

The original isolation of the lanthanide "rare earth" elements—which aren't very rare, save that it was such a horrible job to separate them that it was rarely done—had been done by fractional crystallization. It was said in the last century, when the process of discovering new rare earths was creeping on, that "generations of Ph.D.s were earned tending hundreds of evaporating dishes in the rare-earth laboratories." It took years for the slow multiple fractional crystallizations to separate one from another.

For the work facing the chemists of the Manhattan Project days, this was impossible; most of the elements they were working with wouldn't hang around that long. They'd transmute to something else long before the crystallization was more than started. And anyone working with hundreds of those evaporating dishes definitely wouldn't have generations. At least, not human!

So the nuclear physicists did force on the chemists an engineering development of hitherto esoteric laboratory techniques—ion exchange, and liquid-liquid solution partition techniques for purifying and recovering materials.

They also, of course, presented them with a terrific challenge; the problem of handling uranium hexafluoride. UF_6 is one of those things that exists only in equilibrium with a certain amount of free elemental fluorine. The Germans, during WWII, considered the matter of gaseous diffusion to separate U-238 from U-235, took a look at UF_6 and its properties, shuddered, and spent the war years looking for a more tractable uranium compound.

Fluorine is a very, very nasty element. Chlorine is poisonous, and terrifically corrosive; it chews holes in stainless steel with ease. A little chlorine dissolved in water corrodes away platinum, gold, and almost any metal of ordinary use. But chlorine has an oxidation potential of only about -1.35. Fluorine rates -2.83—it's *really* corrosive. It's also *really* toxic; one single bubble of fluorine escaping

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from a piece of apparatus has been known to kill the careless chemist. It is, incidentally, a substance that no human being will ever smell; since it reacts spontaneously and instantly with water, a human being would smell only the reaction products. Trying to handle fluorine was an enormously difficult problem. Because of its vicious habits, the *first* fluorocarbon compound, CF_4, was not isolated until 1926, and another four years passed before a second, C_2F_6 was isolated.

The first isolation of fluorine, by Moisson, depended on the fact that Moisson was a truly great chemist —and his father-in-law had two important characteristics—faith in his son-in-law, and many millions of francs. Moisson used an apparatus constructed entirely of platinum-iridium alloy—density about 21; raw material costs about three hundred dollars per ounce; melting point so high that construction was exceedingly difficult and expensive. This kind of apparatus—with its ground insulator-stoppers made from calcite crystals (not even free fluorine can attack CaF_2)—was not considered suitable for engineering use. Other men before Moisson appeared to have released elemental fluorine—but their apparatus seemed to have developed leaks; they all died. This made studies to develop a more economical form of fluorine generator somewhat unpopular.

It was finally solved when it was found that several metals—copper, nickel and a number of others—were completely immune to fluorine, even hot fluorine, as aluminum is immune to oxygen. Aluminum on exposure to oxygen, instantly acquires a dense, completely impervious coating of oxide that protects the metal from further attack.

Since ordinary metals would serve, the next step was to get insulators for the electric current that would also resist hot, nascent fluorine. Jewel-crystals, such as calcite or lithium fluoride, don't come in large, industrial-size masses, and it was quite some while before somebody discovered that, for some weird reason, not even hot fluorine would attack common Portland cement!

Once fluorine became available in laboratories not supported by indulgent multimillionaires, the pace of fluorine research had picked up—yet it was 1937 (a dozen years after the graduation of our hypothetical Chemical Engineering Class of 1925) before it was recognized that the fluorocarbons represented a whole field of chemistry—an unexplored territory. Tetrafluorethylene, C_2F_4, was first isolated in 1933—and the concept of fluorocarbon chemistry began to develop.

Just in time to provide the fluorine-handling equipment for the Manhattan Project—the vitally necessary stoppers, insulators,

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flexible tubing, and gaskets that made handling the violently poisonous and viciously corrosive UF_6 a practicable chemical engineering job.

By 1945, our Chemical Engineering graduate was twenty years out of school—and there had been a few other changes in the field of chemistry. The chlorofluorocarbon gases were being used for bug bombs, paint spraying, refrigerants, and their higher-boiling brothers were breaking into the industrial cleaning field.

Silicon had moved from glass to silicone rubbers, oils and greases.

Meanwhile the Manhattan Project, now opening some of its secret files, was discussing elements that did not exist on Earth, because they had no stable isotopes, and were not produced by any natural radioactive decay.*

Promethium, element 61, has no isotope with a half-life greater than 2.7 years; understandably it's not around, whatever may have been its concentration when Earth first formed. Since it's a rare-earth element of the lanthanide group, it's not particularly missed—its chemical properties are practically identical with the rest of the group.

Technitium, Tc, element 43, is more interesting; it has a reasonably long-lived isotope, Tc-97 has a half-life of 2.6 million years, and Tc-98, a half-life of 1.5 million. And it has, for chemists, an interesting characteristic.

Manganese is, of course, one of the most important elements both in metallurgy, chemistry, and geology—and the odd thing about it was that it was "odd Mn out" so to speak. In the Group VII elements, the A family of Fluorine, Chlorine, Bromine and Iodine made a nearly complete family. (Only Astatine, At, the heavy radioactive halogen, was missing.) But the VII-B family was represented only by manganese; neither

continued on page 174

*It is theoretically true that spontaneous fission of U-238 does occur, producing fission products including the nonexistent elements. But uranium's half-life against spontaneous fission is exceedingly long, and the quantity of Tc or Pm in equilibrium is vanishingly minute.

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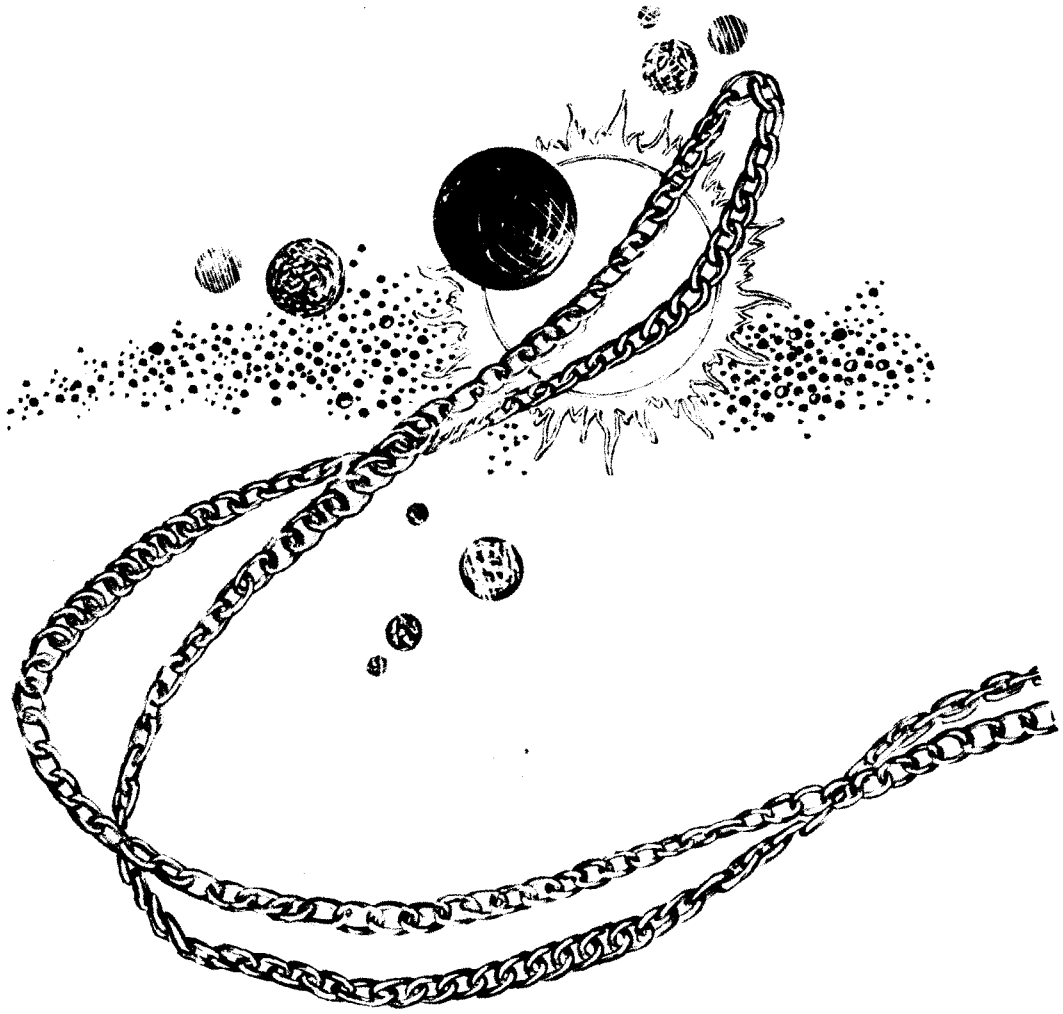

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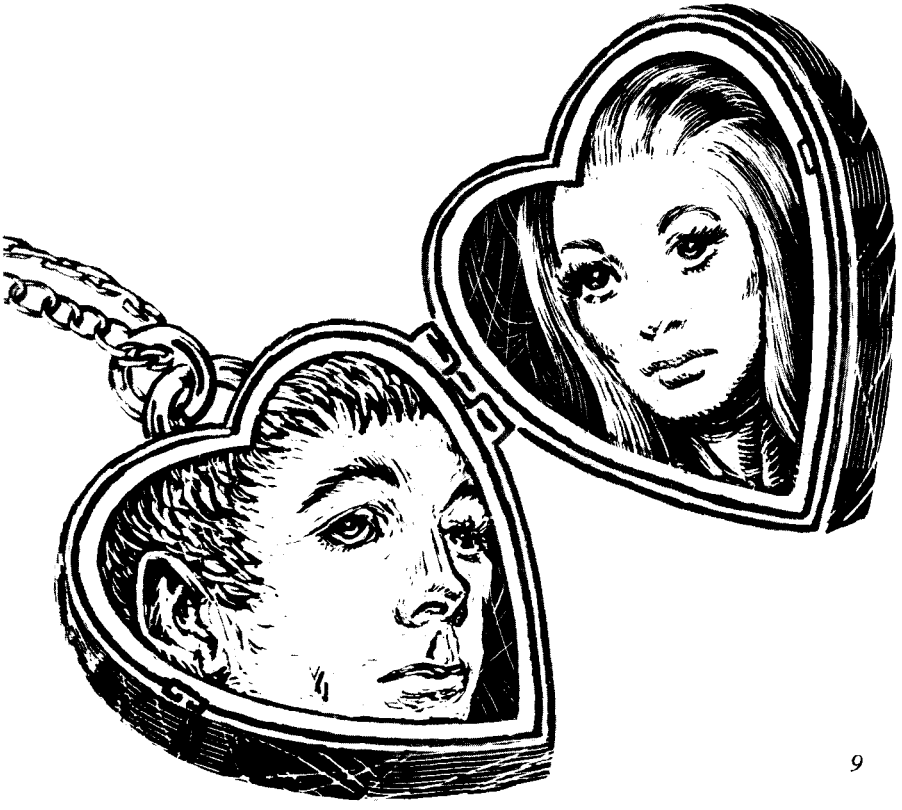
your haploid heart

We've had troubles through all history with the War Between the Sexes. But these people had it far worse . . .

JAMES TIPTREE, JR.

Illustrated by Kelly Freas



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ESTHAA (Aurigae Episilon V) *Type*: Solterran .98

Dom. race: Human to undet. degree
Fed. status: Pending certification
Extraplanetary delegs., embs., missions: None

Esthaa, sole inhabited planet of system, first contact from Aurigae Phi 3010 SP, native cultural level then approx. Terran Greek city states, grouped around inland sea on single continental mass. Navigation, wheel, money, protoalphabetic script, numbers to zero, geometry; smelting, weaving, agriculture. Space trade route estab. 3100 ST. Esthaan students to Gal. Fed., no perm. emigration. Progress rapid in light metals extraction, machine tooling, assembly. Exports: Electronic and mechanical components. Imports: Tool, vehicle and generator prototypes, scientific instruments. Esthaan workers noted for ability to copy complex mechanisms.

Sociological: Since contact, pop. concentration in urban complex around spaceport, becoming one-city planet. Political structure thought to be oligarchy, or council of family heads. Religion unreported. Language one, agglutinative. No known wars except sporadic police actions against nomadic tribes of hinterland known as the Flenn peoples. The Esthaan temperament reported as peaceful and friendly but remarkably reserved.

MacDorra's landsled brought us down fast—Marscots don't waste fuel. Pax lunged across me to peer out my port. I saw the color on his high cheekbones and the light in his eyes. His first big job. He had a severe, luminous eye just like a certain Chesapeake retriever I recalled too well.

Reeling past below was as charming a great garden city as you could wish for. Miles on miles of honey and cream-colored villas in a froth of pinky-green flower trees with here and there, an administrative center or industrial park, like plates of pastel pastry. On the far horizon a gently glittering sea—one-city world.

The spaceport showed beyond a line of wooded hills, and the pilot finally slammed us into a wallowing stall. Suddenly there was a blaze of color in the hills below—red, purple, orange—A carnival? No—a warren of twisted streets alive with people! A hidden village.

Then we were back over spacious suburbs and braking into the field. When the ports cleared we saw a human-looking figure in a soft gold uniform getting out of a rollercar.

The human-looking part was why I was there.

MacDorra's pilot had us and our equipment out into the dust before you could say "parsimony." Three clipboards to sign, a handshake that broke my pencil—"See you in six months, Doc, good luck!"—and we were fleeing for the roller with the field lab while the sled's turbines howled up. The Esthaan came to help. He was big, and seemed amused by MacDorra's operation.

We sorted ourselves out in Interhuman while the roller trundled through tree-lined avenues. Reshvid Ovancha had a well cultivated

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Gal Fed University accent.

Very human, was my snap reaction. He came with the same number of fingers and features, his joints worked like ours, and his skin texture—a feature on which I place great hunch reliance—was a cream-yellow version of my own brown. His eyes were round, with laugh lines, and his smile showed human teeth with an extra pair of frontals. All quite standard, except that his torso looked a trifle thick or blocky. Like me, he was beardless. I could see nothing to explain why, as of that minute, I would bet my tour pay that MacDorra's return would find me with a negative report to file.

Wait till we see the women, I told myself.

Pax was pointing his profile like Scouts of the Galaxy as we trundled up endless avenues bright with suburban shrubbery. Possibly he had much the same idea . . . It has always struck the younger ISB agents as grossly unfair that middle-aged, monogamous and noncharismatic types should be charged with investigating the question of alien sex.

Bureau Personnel learned that the hard way. The first ISB agent sent to Esthaa, over a century back, had been a lad called Harkness. Among other idiosyncrasies, Harkness had had a weakness for laboratory-fermented brew. The sensitive, reserved Esthaans had been very unfavorably impressed when a wing of their new university went up with him. After the investigation and reparations Esthaa had been dropped to the bottom of the sector list to cool off. A hundred years later Auriga Sector had only Esthaa left to check, and the Esthaans had been persuaded to accept another Interplanetary Survey team, guaranteed nonexplosive. Which was now arriving as one Pax Patton, mineralogist-stratigrapher, and one Ian Suitlov, middle-aged ecologist in public and Certified Officer in fact—as Harkness had tried to be before me.

"What's this 'mystery man' bit they give you C.O.s?" Pax had asked me while we were getting acquainted on the ship. I had looked at his eager face and cursed Bureau security.

"Well, there is the Mystery, you know. Silly name, to your generation. But when I started work people were still ready to fight about it. The One-World Crusade was active—in fact, two of my graduating class got kidnapped and were given the conversion treatment. One forgets how much energy and money—and blood—got spent over the fact that human races have been found scattered through the galaxy. It was a highly emotional thing. Powerful religions were upset. Some people wouldn't believe it. Nowadays we've just settled down to the job of counting and describing. We don't call it a Problem. But it is a mystery. Where *do* we

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come from? Are we a statistical peak, a most probable bridge-hand of evolution? Or are we one crop out of one seed pod that somehow got spilled through the stars? People got pretty excited over it. I know one or two who still are."

"But why the Security hang-up, Ian?"

"Use your head. Look at the human position in the galaxy. A new race can get all wrought up over whether or not they're certified human. We know it doesn't really matter—there are Hrattli in top Gal Fed jobs, and they look like poached eggs. But can you explain this to a newly-contacted, proud, scared humanoid race? No! They take noncertification as inferiority. That's why C.O.s are not called C.O.s out loud. We try to get in and get the data quietly before any uproar can start. Ninety percent of the time there's no problem anyway, and C.O. work is the dullest kind of routine. But when you hit one of the emotional ten percent—well, that's why the Bureau pays our insurance. I'm telling you this so you'll remember to keep your mouth very carefully shut about my work. Didn't anybody brief you? You do your rocks, I do my biology—but nothing about humans, humanity, mystery—right?"

"Aye aye, sir!" Pax grinned. "But Ian, I don't get it. What's the problem? I mean, isn't being human basically a matter of culture, like sharing the same values?"

"Curdled Chaos, what do they teach you rock hounds these days? Look: Shared culture is shared culture. Psychic congeniality. It is not humanity. What kind of arrogance could label any general ethical value a criterion of humanity? Being human is nothing so vast. It reduces to one nitty gritty little point: *Mutual fertility!*"

"What a limited concept of humanity!" said Pax.

"Limited? Crucial! Look at the consequences. When we meet and mix with a nonhuman race, no matter if they're totally sympatico and look like the girl next door, the two groups stay separate to the end of time. But when we meet a human race, even if they look like alligators—and some of 'em do—sooner or later those genes are going to flow into the human gene pool, despite any laws or taboos you can set up. Q.E.D. every time—with all the social, religious, political consequences the mixture entails. Now do you see why that's the one fact the Bureau *has* to know?"

Pax had subsided, giving me his Chesapeake stare. I wondered if I had been out too long. Auriga Sector had caught me a month short of Long Leave and talked me into helping close out the Sector survey. "A piece of cake," the chief had called it.

Well, I had to admit that it looked like a piece of cake as we

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rolled up to the palatial Esthaan guest villa. Reshvid Ovancha's horn brought a squad of servants for our bags, and he personally showed us about. It was amazingly like a deluxe version of a Gal Fed faculty residence. Even the plumbing worked the same. The only alien feature I saw was a diffuser emitting a rather pleasing floral scent.

"This is the home of my cousin who is away at sea," Ovancha informed us. "I trust you will be comfortable, Reshvidi."

"We will be more than comfortable, Reshvid Ovancha. We did not expect such luxury!"

"Why not?" he smiled. "Civilized men enjoy the same things!" He made a minute adjustment to the scent dispenser. "When you are ready I will take you to lunch at the University where you will meet our Senior Councillor."

When we rolled through the University gates Pax muttered, "Looks just like Gal Fed campus before the Flower Dance."

"Ah, the Flower Dance!" said Ovancha gaily. "Delightful! Did you encounter Professor Flennery? And Dr. Groot? Such fine men. But that was long before your time, I fear. We live long on Esthaa, you know. A most healthy world!"

Pax's face grew longer. I personally was wondering what had happened to the famous Esthaan reserve.

We met it at lunch. Our hosts were gracious but formal, smiling gently when Ovancha laughed, and gravely observant while he chatted. Some were in faculty robes; a few, like Ovancha, in uniform. The atmosphere was that of a staid gentleman's club.

"We hope you will feel at home, Reshvidi," intoned the councillor, who had turned out to be Ovancha's uncle.

"Why not?" laughed Ovancha. "Now come, you must see your laboratories."

The laboratories were very adequate, and by evening we had our schedules and contacts set.

"Do we have to go to all those dinners?" Pax complained. He was prowling the patio and eyeing the line of distant mountains, where two pink moons were coming up. Fountains tinkled and a bird sang.

"One of us must. You can start some field work."

"While you look into the fertility. Say, Ian, how—"

"With a culture tank," I told him, "and a great deal of caution. *And* it is a ticklish business until you know what the taboos are. How do you think Victorian England, say, would have reacted to a couple of aliens who demanded a look at people's sex organs and a fresh slice of someone's ovary? I'd like to get it through your head that this is a very good subject to shut up about."

"Aren't you up too tight, Ian? These people are very enlightened types."

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"One of my friends had both feet cut off by some supposedly enlightened types."

Pax grunted. Maybe I *had* been out too long. Why did this place give me the feeling of a stage set? It was so insistently human-norm. Well, I'd know more when I saw the women.

Three weeks later I was still wondering. Not that I hadn't seen Esthaan ladies—at dinners, at lunches, at merry family picnics, even on a field trip with two lady marine biologists. Or rather, with what passed for biologists on Esthaa: it had soon appeared that with all the shiny instruments, science on Esthaa was more an upper-class hobby than a discipline. People collected oddities and studied what amused them, without system. It was an occasion for wearing a lab coat, just as their army seemed to be merely a game of wearing uniforms. My Esthaan ladies were like everything else here, charming, large, and wholesome. And decorously mammalian to outward view. But had I seen *women?*

Well, why not? As Ovancha would say—I needed a closer look.

The usual approach on an advanced planet is through the schools of medicine. But Ovancha had been right in claiming Esthaa was healthy. Aside from injuries and a couple of imported infections now controlled by antibiotics, sickness did not seem to exist here. *Medicine,* I found, referred to the pathology of aging; arthritis, atherosclerosis and the like. When I asked about internal medicine, gynecology, obstetrics, I was stopped cold.

One chubby little orthopedist allowed me to take a few measures and blood samples from his child patients. When I persisted in asking to see adult females he began to dither. Finally he sent me to a colleague who reluctantly produced the cadaver of an aged female worker, a cardiac-arrest case. She had evidently been operated on for hernia in middle life.

"Who did this operation, Reshvid Korsada?" I asked. He blinked.

"This is not the work of a doctor," he replied slowly.

"Well, I would like to meet the person who did this work," I persisted. "Also I would like to meet one of your doctors who assist in delivering new life."

He laughed embarrassedly and licked his lips.

"But—there is no need for doctors! There are certain women—"

He ran down there, and I saw the sweat on his forehead and talked of other matters. I have not lived twenty years in this job by poking sticks into sore places, and I wanted to make that Long Leave back to Molly and the kids.

"These people are touchy as a pregnant warthog," I told Pax that night. "Apparently birth is so taboo

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they can't mention it, and so easy they don't need doctors. I doubt these medicos ever see a woman naked. Like Medieval Europe where they diagnosed with dolls. This is going to be very ticklish indeed."

"Can't you count chromosomes or something?"

"To determine *fertility?* The interior of the cell is not called the last fortress of neg entropy for nothing. It's the *pattern* that counts; quantitative DNA analyses and the few gene loci we know are nothing. The only reliable index we have is the oldest one of all—you bring a male and female gamete together and see if the zygote grows. But how in Mordor am I going to get an ovum?"

Pax guffawed. "I hope you don't expect me to—"

"No, I don't. I'll put in time cataloguing and figure something out. How are your rocks, by the way?"

"That reminds me, Ian, I think I've hit a taboo myself. You remember that village we saw coming in? I asked Ovancha's wife about it last night, and she sent the kids out of the room. It's where the Flenni live. She said they were *silly* people, or *little* people. I asked her if she meant *childish*—at least I think that's what I said. That's when she sent the kids out. Why don't they hurry up and invent that telepathic translator the videos show?"

"Maybe it's some tie-up with child . . . baby . . . birth."

"No, I think it's the Flenni. Because of what happened today. I was out on that geosyncline back of the port and I heard music—from the village. I started over, but suddenly here comes Ovancha in the university roller and tells me to go back. He said there was sickness there. He almost hauled me into the roller."

"Sickness? And Ovancha was right there? Indeed I do agree with you, Pax. I'm very glad that you thought of telling me about this. And as nominal head of this mission," I continued in a tone that brought his stare around to me, "I want you to stay away from the Flenni and any other sensitive subjects you happen across. I'm responsible for getting us out of here in one piece, and there's something about this place that worries me. Call me what you like, but *stick to rocks.* Right?"

For the next two weeks we were model agents. Pax made a brief coastal profile, and I buried myself in routine taxonomy. One of my chores was to compile a phylogenetic survey of native life forms based on the Esthaan's own data. Their archives were a curious jumble of literary bestiaries, and morphological botany, topped off by a surprisingly large collection of microscopic specimens. It was abominably muddled and dispersed. To

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my astonishment, in a packet of miserable student mounts of rotifers I came upon what I realized must be Harkness's work.

Back at base they had told me that all Harkness's data vanished with him. I had taken the trouble to look up the old report of the ISB inquiry. There seemed to be no doubt that Harkness had been running a still, and that there had been a big fire. The only note the ISB team found was on a scrap of paper in a drain. In a large and wavery script were the words, "MUSCI! They are BEAUTIFUL!!!"

Musci are, of course, terrestrial mosses, unless Harkness had been abbreviating Muscidae, or flies. Beautiful mosses? Beautiful flies? Clearly, Harkness was a rumhead. But he was also a first-rate xenobiologist when sober, and his elegant mounts, still clear after a century, saved me a lot of work. The neat marginal chromosome counts were accurate. There were other brief notations, too, which began to get me very excited as my data piled up. Harkness had been finding something—and so was I. The problem of getting human gametes receded while I chased down the animal specimens needed to fill in the startling picture.

In our free evenings, Pax and I took to cheering ourselves with song. It turned out we were both old ballad buffs, and we worked up a repertory including "Lobachevsky," Beethoven's "Birthday Calypso," and "The Name of Roger Brown." When we added an Esthaan mouth organ and a lute I noticed that our Esthaan house-factor was wearing small ear muffs.

Our reward for all this virtue arrived one morning in the form of Ovancha with a picnic hamper.

"Reshvidi!" he beamed. "Perhaps today you would like to visit the Flenn?"

We trundled out across the spaceport and over a range of low hills in bloom. Then the roller lurched into a gorge under a shower of flowers, and jolted up a stony pass in which there were suddenly adobe walls, brilliantly colored in hot pink, greens, electric blue, purple, dry-blood color and mustard. I caught the start of an amazing smell as we burst over the hilltop and into a village square. It was empty.

"They are timid," said Ovancha apologetically. "The sickness also has been hard."

"But I thought you didn't have —" said Pax, and glared at me for the jab.

"*We* do not," said Ovancha. "They do, because of their way of life. They have a bad way of life, bad and silly. They do not live long. We try to help them, but—"

He made a graceful gesture and then tooted melodiously on the roller's horn. We got out. Shrill orange flowers were blowing across the cobbles. The smell was remark-

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able. From somewhere a flute blared brilliantly and stopped. Across the square a door opened and a figure limped toward us.

It was an old man, robed in blue. As he came up I saw he was very delicate—or rather, Ovancha suddenly became an oversized rubber truncheon. I stared; something about the old man was sending strongly to my hunch-sense.

I had missed Ovancha's introduction.

We began to walk down a side street. It, too, was empty. There was an overpowering feel of hidden eyes watching, ears listening. A gate snicked shut like a clam shell. The houses were interspersed with tents, pavilions, shanties, dark recesses which rustled.

We came to a courtyard covered with a torn green canopy. Under it a dozen frail old people reclined silently against the curb. Their faces were turned away. I could see their skeleton hips and ribs under the bright, soiled cloaks. Was this the sickness of which Ovancha had warned Pax? But he had led us right to it.

Suddenly a side door creaked and out into the silent scene there burst a flock of children. The old ones roused, held out shaking arms, smiling and murmuring. Voices were calling urgently from the doorway, but the little ones ran wild—incredibly tiny and active, fluttering gay silks, shouting high and sweet. Then a robed figure ran out and herded them inside and the old ones sank back.

Ovancha was making a strange sound. I saw his mouth working in a greenish face as he marshaled us back toward the roller.

But Pax had other ideas. He strode smartly on around a corner. Ovancha threw me a distraught look and went after him. I followed with the limping old man. We proceeded thus around a second corner, and I was about to shout after Pax when a flurry of silk came shooting out of the wall beside me.

I felt my hand clutched by something tiny and electric. An impossibly small girl was running beside me, her face turned up to mine. Our eyes met, joltingly. Something was being pushed into my fist. Her head went down—soft, fierce lips pressed my hand—and then she was gone.

Twenty years of discipline strove to open my fingers. The old man was gazing straight ahead.

We came up to Pax and Ovancha in the square. I saw Pax's back was rigid. As we said our farewells he gripped both the old man's hands in his. Ovancha seemed pale. As the roller started, the unseen flute pealed out again and was joined by a drum. A trumpet answered from across the square. We drove away in a skirl of sound.

"They are fond of music," I said inanely. My hand felt on fire, and Pax's eyes were smoldering.

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"Yes," said Ovancha, and added with an effort, "some do not call it music. It is very harsh, very wild. But I find . . . I find it has some charm."

Pax snorted.

"In my home," I said, "we have also an animal like your *Rupo* which we use for hunting. They have a very strong character and think only of hunting. Once my friends and I took a certain *Rupo* on a hunting trip and, as is also your custom, we drank wine with our lunch and sometimes did not hunt in the afternoon. The *Rupo* regarded this as a sin. So one night when we were many days from base he carried all the wine bottles to a deep swamp and buried them."

They both stared at me and Ovancha finally smiled. The tension broke.

Back at the villa I saw Pax's mouth opening and pulled him over by a fountain.

"Keep it low," I told him.

"Ian, those people are human! They're the only human Esthaans I've seen. These owl-eyed marshmallows—Ian, the Flenni are the people you should be looking at!"

"I know," I said gently. "I felt it, too."

"Who are they? Could they be the survivors of some wreck?"

"They were here before First Contact."

"They're terrified of the Esthaans. I saw them run for cover as we came up. They're in trouble, Ian. It isn't right. You've got to do something!"

He was flushed and frowning. Just like the Chesapeake the night before he imposed Prohibition.

"You, Dr. Patton, are a professional mineralogist, sent here at enormous cost to do a specific job your Federation wants done. Same here. And our jobs do not include mixing into native political or social conflicts. I feel, as you do, that the Flenni are an appealing native group who are being oppressed or exploited in some way by the civilized Esthaans. We have no idea what the history of the situation is. But the point is, *we are not free to endanger our mission* by intruding into what is clearly a very tense position. This is something you will have to face on planet after planet in order to do your job. It's a big galaxy, and you'll see worse things before you're through."

He blew out his lips. This was not like the videodrams.

"I thought your job was to find humans."

"It is. And I'll check the Flenni before we're through. And I'll report their condition, for what good it'll do . . . Now let me tell you something I suspect. Did you ever hear of polyploidy?"

"Something about big cells—what has that got to do with the Flenni?"

"Bear with me. I can't be sure until I get a few more specimens,

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but I think we've come on something unique: Recurrent tetraploidy in the higher animals. I've found it in eighteen species so far, including rodents, ungulates, and carnivores. In each case you find two closely similar animals, one of which is bigger, stronger and more vigorous. And tetraploid—that means, by the way, not big cells but an extra set of chromosomes. It's a mutation. Tetraploidy and higher polyploid mutations have been used on many planets to produce bigger and better food plants, but it's almost unknown among animals. Here you have it all over the place—again often in the tame domestic form. That big cowlike creature they milk has twice the number of chromosomes the little wild cow has. Same with their wool-bearing beast and the wild sheep. Their common rodent has twenty-two chromosomes, but I trapped a king rat—a gigantic brute—with forty-five. Harkness was working on it before me. Now, do you see what the possibility is?"

"You mean, these Esthaan jumbos are tetraploid Flenn?"

"That's exactly what I expect to find. And if so, what?"

"Well, what?"

"A case where nature has set the stage for genocide, Pax. The two forms compete, and the bigger, stronger, more vital form wins. The Flenni are weak, short-lived, defect-prone and they are up against people who are simply more of everything they are. Shocking as it sounds, you have here almost a quantitative measure of humanity —if they're human. Under the circumstances, it's a credit to the big Esthaans that the little race has survived so far. Remember, *our* species tolerated no living relatives."

"But . . . if they could be given a place of their own . . ."

"Provided the mutation isn't a recurrent one. If it is recurrent, the situation will only repeat. And it looks as if it is . . . why does each species have a tetraploid companion? If there had been only one mutation 'way back, the separate evolutions would have diverged. Now I suggest we quit talking and play something. How about 'Hold That Tiger'?"

But our hearts weren't in it. When we turned in I took a look at the note which had been burning a hole in my pocket.

Doctor from the stars come to us! Help us dying we pray.

I slept badly. In the morning we found a sheaf of the vivid orange flowers had been thrown over the wall by our table.

Ovancha joined us after breakfast. With him was a muscular young Esthaan wearing high boots and imported dark glasses.

"Reshvid Goffafa!" Ovancha announced. "He is ready to guide Reshvid Pax to the volcanic mountains. Perhaps this is too short notice? But Reshvid Goffafa has

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classes beginning just after the rest days and he has returned specially for you!"

With Pax gone I concentrated better and in a few days steady drudging I had turned up three Harkness slides marked *Fl.* In a collection of waterplant tissues I found a firmly stained section marked *Fl. Inf., vascular marrow* which gave me what I needed. There were karyokinetic anomalies, but the chromosome count was clearly half of that on my Esthaan samples. My involuntary satisfaction gave me a pang of shame; the thing was a tragic trap for the Flenni. And mixed with the pang was something like a faint voice saying "Tilt" over the whole beautiful structure. But surely Harkness—

"You study in a trance!" laughed Ovancha, who had entered quietly.

"It is our way," I returned absently. It had just struck me that Ovancha was unusual in another way. He had gray eyes, the norm was olive-brown. And the old Flenn also had gray eyes.

"I wonder what you see." There was a hint of seriousness under his light tone. Was it possible that Ovancha was different enough to be of use to me?

"I see something of great scientific interest on your delightful planet," I began hopefully. He seemed to follow, but when I tried to show him a chromosome his aristocratic eyelids drooped, and he barely glanced through the scope. When I spoke cautiously of a possible genetic difference between himself and unnamed "others" his mouth twisted.

"But one can see the difference, Reshvid Ian!" he reproved me. "There is no need to go further. We are not interested in such things in our science."

No help here. I began chewing on the problem of obtaining Esthaan gametes, while Ovancha chatted on about a Reshvid doctor who perhaps had some slides, and a Reshvid somebody else who would be delighted to show me his preserving technique—after the rest days, of course. Meanwhile, since no one was really working now, why not come to dinner and view the museum president's collection of luminous sea bats?

The next day the university blimp-flier went out to pick up Pax and Goffafa, but they were not there. No one was concerned, since they had ample supplies. It was decided to try again in three days. The second try was also unsuccessful, and the third. Ovancha told me tensely that Goffafa was now late for classes.

The orange flowers came over the wall again that night. At noon next day a uniformed Esthaan appeared in my lab and told me I was to come to the councillor's office.

Ovancha was standing outside.

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He acknowledged me with a curt nod and went in, leaving me to stare at the antiseptic and cylindrical maiden behind the desk.

When I was ushered into the presence of the white-haired senior councillor Ovancha was looking at a wall map. I was not offered a chair.

"Reshvid Ian, your colleague Reshvid Pax is a criminal. He has committed murder. What have you to say?"

I stammered my bewilderment. Ovancha wheeled about.

"Reshvid Goffafa is dead. His body was found buried in an obvious attempt at concealment. He died by strangulation. Your colleague Pax has fled."

"But why should Pax do such a thing? Why do you believe he was the murderer? He admires and respects your people, Reshvid Ovancha!"

"The murderer was large and strong. Your friend is strong—and he is excitable, uncontrollable. Disgustingly *silly!*"

"No—"

"He quarreled with Reshvid Goffafa, killed him and fled."

"When Reshvid Pax returns," I said, fighting for anchorage, "I hope you will listen to his explanation of the sad death of Goffafa."

"He will not return!" Ovancha fairly shouted. "He has sneaked into a camp of Flenni and is hiding there. Do you dare to suggest he is not guilty?"

The councillor cleared his throat sharply and Ovancha's mouth snapped shut.

"That is all," said the councillor. "You will be so good as to stay in your quarters until transportation is arranged. I regret that your laboratory here is closed."

The next days passed in that agony of boredom and worry known only to those who have been alone and in jail on an alien planet. My field kit was returned to me; I set it up and forced myself to study the garden flora. There was a sentry outside the gates. There was a nocturnal scuffle, and no more flowers came over the wall.

Then one night the almost-cat had kittens.

I had been pacing the terrace. Senior ISB biologists are not supposed to get the shakes, the *horror alieni.* Certainly on the surface I was in no danger. Pax was in serious trouble, but all I faced was grief from the Sector over a fouled-up mission. And yet I could not get rid of the notion that an invisible set of jaws were all around me and about to go crunch. Something here was wrong; something that killed biologists. Harkness had been a biologist, and he was dead.

I became aware of action by my feet, under the amber ferns. The pet we called the almost-cat was rolling on the ground, among a heap of small, scuffling, squeaking things. I focused my pocket light,

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and the "cat" suddenly sat up, yawned in my face and sauntered off, leaving me gaping at the wiggling heap on the ground. Kits! But how many were there? A dozen tiny faces turned up to the light—two dozen—four dozen—and how tiny! Still more were struggling or still among the fern roots.

I picked up a handful and started up to my lab.

In my head all the puzzle pieces which had fitted themselves so neatly into that damned wrong pattern were again in motion—coming together in a larger, frightening pattern. One of the items in the new pattern was the great likelihood that I would be killed. As Harkness had been when he stumbled on the truth.

Could I conceal it? No chance; two sleepy servants had seen me with the kits, and I had said far too much to Ovancha.

I worked carefully. It was gray dawn when the microscope had abolished all possible doubts. Outside a sweeper-boy with a box was scrabbling under the amber ferns. He had some trouble—the kits, four hours old, were running and biting—but he got them all. He took the box to the back gate and passed it to the sentry.

Even unto the least, I thought dismally. More pieces fell into place. Why had I not considered the city more? When I turned Ovancha was in the room. His gray eyes flicked over my bench.

"Good morning, Reshvid Ovancha. Has there been word from Pax?"

Some of the anger fell from his face, leaving it grave and full of human trouble. Human! How desperately they had wanted the meaningless certification. How intricately they had built! Ovancha must have been one of the leaders—exceptional Ovancha, able to dare, to cope with us. He was speaking with obvious pain.

"Reshvid Ian, why do you—We . . . I have welcomed you as a friend—"

"We, too, wish to be friends."

"Then why do you occupy yourself with *revolting, unspeakable things*?"

He was asking in all seriousness. It was not just a futile plot! It was a real and terrible delusion. They had somehow come to hate what they were so unbearably that they were living a myth of denial—a psychotic fantasy. Had Harkness done it? What had he told them? No matter—we had punctured it now and there was no hope for us. But I must answer his question.

"I am a scientist, Reshvid Ovancha," I said slowly. "In my world I was trained to study all living things. To understand. To us, life of any sort is neither good nor bad. We study all that lives, all life."

"All life," Ovancha repeated desolately, his eyes on mine. "Life—"

Pitying I made my greatest blunder.

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"Reshvid Ovancha, perhaps you might be interested to know that in my original world we had once a very great problem because our people were not all alike. We had not two but many different peoples who hated and feared each other. But we came to live together as one family, as brothers—"

His eyes had dilated, and I saw his nostrils flare. His lips rolled back from his teeth—the face of one hearing the ultimate insult. His hand twitched toward his ornamental side arm. Then his lids fell. He turned on his heel and was gone.

The least likely male can move with unexpected agility if he is sufficiently motivated, and if his employers have insisted on regular training courses. As Ovancha went downstairs, I went out the lab window with a bundle, and over the kitchen roof to the wall, which was set with broken glass.

I landed in the alley on an ankle that felt severed, and a cheek and arm full of glass. I put on the Esthaan cloak and hobbled up the alley. Each block had a walled center alley that concealed one from the sides, but I had to cross the wide avenues between blocks. Luckily it was just dawn. I had made three crossings when a big roller full of uniforms whooshed by the end of the block I was in.

I limped four more blocks, my face and arm on fire, and my ankle gave out. There was a trash recess in the wall. I dodged in—how quickly fugitives connect with garbage!—and listened to the Esthaan police bell clanging from the direction of my home.

Suddenly a big mustard-colored roller came swishing into my alley and stopped fifty feet away. I heard the driver get out. A gate bell tinkled, and the gate opened and closed. Silence.

I made it to the roller, pulled open the tailgate and scrambled inside. It was roomy and dark, with a piercing odor. I got behind some crates next to the canvas that closed off the driver's compartment.

The tailgate opened and a crate slammed in. Then we were off.

I believe I wept when I heard the sounds coming from the crate. If my luck held—if the driver didn't take all the crates out—if I could hold out against what was now clearly poison in my cuts—if . . .

For hours of agony the truck started and stopped, opened to receive more crates, slammed and jolted on. The noise inside would have covered a trumpet solo, and the smell was a stench. Finally came the steady drumming of a highway, and when I had lost almost all hope, we stopped.

The driver got out and came around to open up. This was bad. I had done some knife work on the canvas curtain, but I wasn't sure I could move. Frantically, I cut the last threads and pushed and rolled myself through to the front floorboards. The pain was shocking.

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There were figures outside the open cab door, but no one heard me above the uproar. I heard the tailgate slam—the driver was coming back. I cried out and pitched myself out.

I must have blacked out as I hit. The next thing I heard was the crunch of the roller's tires by my head. Something filmy was over my face, something was pressing me down. I felt quick hands on me, voices whispering: "Stay down!"

I stayed down, all right. The world went away and didn't come back except as hot clouds of pain and confusion for several days.

My first really clear moment came in the form of an endless plain of grass lurching across my view. I focused interestedly, and it stayed put. It was I who was doing the lurching, tied into the saddle of a pack beast.

Ahead of me was a small hooded rider. I gazed contentedly at the saffron robes, reveling in no-pain. We had, it seemed to me, been traveling thus for some time.

The rider ahead looked about, and suddenly my beast was prodded into violent flight across a stream bed. Then both beasts were under trees, and the rider was off and racing up the bank in a whirl of silk. This, too, seemed to have happened many times before—and there had been night and stars, and hot days in thickets, and pain, and soft hands.

My guide returned, slowly, throwing back the hood. The face I saw was the flower face of the child who had put the note in my hand. Her eyes were smiling stars, her hair was the night sky, as she bent over me. I breathed in her perfume. And then I remembered what I knew.

"Friends come now," she smiled, the voice like a bird's wing.

She laid a slight, violently alive hand over my heart, and we stayed thus until hoofbeats pounded close. There were three bright-robed Flenni and a larger rider—

"Pax!" I croaked.

"Ian, man!"

"Where are we?"

"You're coming to the mountains. To the camp."

But my little guide was already up and riding away. *Of course,* I thought, my knowledge a cold sadness. The men had stayed hooded, too.

They got me up and going, although I kept twisting round against the pain to see her dwindling across the savannah. Pax did most of the talking.

"What happened to Goffafa?" I asked.

"That *kralik*. We came to a party of Flenn women. He was going to shoot them down."

"Shoot them?"

"He got wild, as if they were dangerous vermin. I had to take his gun away. Like fighting a rubber octopus. He glared at me and

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foamed, and believe it or not he threw up his lunch. Agh! I got him in the roller and he tried to brain me with the Geiger."

"So you strangled him?"

"I only choked him a little. Last I saw of him he was crawling. I was going to come back for him when he cooled off."

"He's dead. The Esthaan Council has you booked for murder."

Pax gave a growl of disgust.

"Some Flenni found him during the night. They told me he shot two of them when they offered him water, and they finished him. I believe it."

He smote his boot, and his mount curvetted.

"Those swine, Ian! I can't begin to tell you what I've learned. The Esthaans won't let them raise food! The Flenni start farms and the Esthaans come out here in those gasbag fliers and spray poison. They poison waterholes. Ian, they're forcing the Flenn into those shantytowns where they can keep them under their thumbs. And I believe they *spread* that sickness, they don't cure it. They're trying to kill them off. Ian, it's what you said. Genocide!"

Our guides, hearing the word "Esthaan", had turned their now unveiled heads to us. It was my first look at young Flenni males.

Handsome was no word for the intensity of life in their proud beaked faces, their brilliant eyes and fine nostrils and lips. They had male beauty, and something more —virility that blazed and yet was somehow vulnerable. I knew I was seeing human males of a quality none had seen before. Involuntarily I bowed my head to acknowledge their gaze. They returned my bow and looked away, their profiles pure and grave against the mountains.

"Pax, it's not—" I began, when my mount careened forward under a Flenn whiplash and we were racing pell-mell for a clump of scrub. Behind us arose a soft unearthly hooting. I got a glimpse of a golden contraption about fifty feet up and coming fast. We careened on. Pax was fighting his mount. A black smoke began belching from the flier's nose.

Pax flung himself to the ground as I was swept into the copse. There was a roar and a confused crashing, and the Flenni had dragged me off and were covering my head. For several heartbeats nothing happened.

I got an eye free. The black stuff was blowing past us. The gasbag flier was down on one side and the pilot was struggling out with a gun in one hand. Pax was somewhere in the smoke.

The gas was making me slightly dizzy, but the Flenni were out cold. I fumbled around in my swaddling and found the pistol still in my bundle. The second shot got the pilot's wrist, and then Pax stumbled out of the smoke and fell on him.

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We had the pilot nicely trussed up when our Flenni revived. There was a little difficulty in making them understand that I wanted him alive, and they threw him behind my saddle with the controlled disdain one shows to a dog who rolls in dead fish. They were enthusiastic about helping Pax rip out the flier's transmitter and load it on.

We rode on in silence. My captive's face was in rictus and his eyes were rolled up. I reflected on the curious difference in the hate shown by Esthaan and Flenn. Why was it the big, victorious Esthaans who panicked like cornered rats? In twenty years of strange and often pitiable cases I had seen nothing sadder.

Pax was outlining his plan. He had, it seemed, worked up his field kit into a transmitter which, with the flier's power packs, should be able to contact MacDorra when the freighter came near.

"What makes you think MacDorra will rescue us?" I asked him. "We're both under murder charges. MacDorra won't offend a planetary customer. And he'd let his mother drown rather than pay for cleaning his dress uniform, you know that. The most he will do is slow-signal the Sector HQ—collect—for instructions . . . the very most."

"It's not a question of rescuing *us!*" Pax told me indignantly. "I'm going to see the Flenni get justice. I want MacDorra to send an emergency message to Gal Fed charging the Esthaans with genocide and asking for intervention. The Flenni are human beings, Ian —I don't know what the Esthaans are, but I'm not going to stand by and watch humans wiped out by some kind of *things!*"

"Justice?" I asked weakly. "Genocide?" It was all my fault, but I was suddenly too tired.

"Not genocide, Pax," I muttered and blacked out in my saddle. The image of the girl who had guided me kept me company in the dark.

I woke to find myself in the

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Flenni camp. An enormous cavern, sparkling with camp fires, rustling with silk and loud with song. The voices, naturally, were all masculine; only males were here. I was fed and put to rest against my saddle amidst the quick feet, the soft fiery voices. The air was pungent with smoke and Flenn.

During the night I found that the pilot had been dumped near me, still trussed like a sausage. He was the fattest Esthaan I had ever seen. When I cleaned his wrist he writhed and turned purple, and presently, like Goffafa, he foamed. I gave him water, which he vomited. Finally he lay with eyes wide and glaring, breathing loudly and sweating rivers. I checked his circulation and lay down to sleep.

Pax was conferring with a group of young Flenni when I woke. He towered among them, bronzed and eager. Every inch the guerrilla leader of the oppressed. There would have to be explanations . . . but my head ached very much, and I took some fruit and went to sit outside the cave.

An old man came quietly to join me.

"You are a doctor?" He used a noun meaning also *wise man.*

"Yes."

"Your friend is not," he said.

"He is young. He does not understand. It is only recently that I myself have understood."

"Can you help us?"

"I do not know, my friend. There is nothing like this on other worlds I have seen."

He was silent.

"About the sickness," I asked. "How is it done?"

"With music," he said grimly.

"Can you not block the hearing?"

"Not enough. Not enough. I myself survived three times, but then—"

He grimaced, looking at his hands. Frail, parched, the hands of great age.

"I will die soon," he observed. "Yet only this spring I helped open the Great Cave."

"Where are the women?" I asked after a bit.

"To the north, half a night's ride. Your friend knows the way."

We looked at each other in silence. I dimly recalled Pax's figure against the cave mouth during the night.

"You live long," he mused. "Like the others, the Esthaans. Yet you are like us, not like them. We knew at once. How is this possible?"

"It is thus with all the worlds we

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know. And only here is it different."

"It is a bitter thing," he said at last. "My friend from the stars, it is a bitter thing."

"Explain to me a little more, if you will," I said. "Explain how it is with the sickness."

When I went in search of Pax I found him jubilant amidst a tangle of wiring.

"I've made contact!" he announced. "MacDorra's in the system! They acknowledged my Mayday and the Federation Emergency appeal."

I groaned.

"The genocide part, too?"

"Right. I requested emergency transport and asylum for the Flenni."

"Have you checked this with the Flenni?"

"Why, it's obvious!"

I held my head.

"Pax, it's all my fault. Have you ever heard of the general class of plants called Bryophytes, chief of which are the mosses, or Musci? Have you ever heard of the Terran animals called Hydrae?"

"Ian, I'm a geologist!"

"I'm trying to tell you, the Esthaans are not committing *genocide*, Pax. It's parricide, filicide . . . perhaps *suicide*—"

There was a high-pitched commotion behind us, and a racing figure that streamed pale gold rounded the transmitter and materialized before me into the loveliest girl I had ever seen. I simply gaped at her. Honey and pale flame, high-arched breasts, tiny waist, full oval haunches, an elf's hands and feet, and the face of a beautiful child in love—unfortunately, turned on Pax.

Then she was in his arms, her luminous face eclipsed in his chest, her little hands clutching and caressing him.

Having no hope of being included in this communication, I turned and saw that the camp was in motion. Saddles and bundles were being hoisted, fires stamped out. Angry voices echoed. My friend the elder was standing quietly with others.

"What is happening?" I asked.

"They have captured the women. The young Flanya, who was with your friend, returned to her camp to find the soldiers there, and rode to warn us."

"What can be done?"

"There is nothing to do but flee. They will come here—they will drive them here with the music. Against the music we can do nothing. The young men must be gone. As for myself and these others, we will wait. We will see our women once more before they kill us. If only . . . if only they do not hurt the women—"

"Do they dare?"

"It was not always so. But in recent lives I think they grow mad. It is becoming unthinkable. I fear that when they find the men gone

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they will drive the women after them and on—"

His voice failed. Pax had somewhat disentangled himself, and the girl was veiling her face.

"How many Esthaans are there?"

"About thirty, Ian; it was too dark to see well. I'm sure we can take them. I've got eight pretty fair marksmen with handguns, plus the converted ditcher and our two heavy guns. The damnable part is that they intend to use the women as cover."

"Pax, I cannot allow you to shoot Esthaans, and the boys you have trained cannot stay here—they must get out. Listen, Pax, what's coming here is nothing you can fight with guns. All you'll see will be the Flenni girls, plus some mobile sound equipment. You've got to listen! The Esthaans and the Flenni are one—"

An ear-splitting screech came from under our legs. The Esthaan pilot, who had been huddled puffy and fasting, now lay on his back kicking like a frog. Flenni who were moving outwards turned at his screams.

"Look here, Pax!" I shouted above the din. I ripped at the pilot's clothes, exposing his swollen body. Two great angry scars ran from each pubic ligament to above the crest of the pelvis.

"He's a woman!" Pax exclaimed.

"No, he's not. He's a sporozoon —an asexual form that reproduces by budding. Watch."

The pilot had collapsed into moans, his body racked by wave-like contractions. Several Flenni had brought up large baskets stuffed with silk.

"I think most Esthaans are not informed of their true nature," I told Pax. "This man probably believes he is dying."

A supreme convulsion swept over the Esthaan, and the two gashes in his flanks swelled, pulsed, and slowly everted themselves like giant pea pods turning inside out. A mass of wriggling blobs of flesh tumbled down his sides. He was screaming. I pinioned his flailing legs, and the girl Flanya rushed forward with the baskets. A high wailing—with which I was very familiar—rose from the mites as we gathered them. I held one up to Pax.

"It's . . . It's a Flenn child!" he exclaimed. It was unmistakable—barely an ounce of male life, with bright gold eyes, clutching, kicking and keening. I laid it on the silk and showed him another, an even smaller female with coordinated eyes and the start of a smile reflex. And a withered leg. There were others with defects, or lying still.

The Flenni were plucking my arm. I stepped back and they ran with the baskets to mount and go. I threw the pilot's tunic over his empty belly; he had fainted. We were alone now, the old men, Flanya and Pax.

"Do you see, Pax? A case of alternate generations, with both the

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sexual and asexual generations fully developed and complete. Unheard of. It only lasted as far as the mosses and hydrae on Terra, and then the sporogenetic form took over the gametes—that's you and I. We're somatic sporozoons, our gametes are reduced to cells. The Esthaans are not tetraploids, Pax—they're normal diploids. But the Flenni are living gametes, with a half-set of chromosomes each. They mate and produce Esthaans—who spore out Flenni, alternately and forever."

"You mean the Esthaans and Flenni are *each other's children?* But—we saw Esthaan families!"

"No. Their Flenn offspring are carried secretly out to the Flenni village, along with newborn dogs, cats and everything else, and the Esthaan offspring of the Flenn are brought in for Esthaans to raise. Pseudo-families roles. It's literally insane—they may have built it up after Harkness told them they weren't human. Listen!"

A throbbing pulse was in the air. One of the elders caught my eye.

"Pax, barricade this transmitter and get the power leads out of sight. I'm going to try a forlorn hope."

He raced off, Flanya behind him. I turned to my old friend who spoke Esthaan.

"This machine will carry your voice to men like me on other stars," I told him. "First I will speak, and then you must say what I will now tell you."

As I was coaching him, the throbbing strengthened, and was joined by a rippling, wailing moan which rose and fell with frightful effect on the ears—no, on the nerves. The other elders drifted towards the cave mouth, staring blindly. A flash of silk caught my eye.

"Pax! Grab her!"

He was deep in wires. I forced my legs into a sprint and tackled her fifty feet from the door. Her eyes came round on me, staring-wild, and her body plastered itself against me like an electric eel. The drum note was pulsing through her like a resonator. I finally found a spot on her neck which put out the crazy life in her eyes.

"Take her back and tie her up!" I howled over the rising hurricane of music. "Do you understand? Tie her tight if you want her alive!"

We made it behind the barricade as the first women faltered into sight beyond the cave.

I grabbed the mike and began sending to the only source I knew which might get action from the gray remoteness of the Federation Council. If only Pax's lash-up worked! If only the electronic bedlam outside wasn't jamming us! I repeated, and passed the mike to the elder. His whispered, gasping and yet vibrant, voice would melt stone—if MacDorra had his recorder on.

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"What's that about the Flenni being human and the Esthaans not?" Pax hissed. "I thought you said—"

"Pragmatic definition. How can you fertilize something that doesn't have gametes? Ergo, the Esthaans are nonhuman, right? By the same token, whose child is Flanya carrying? Ergo—Quick, find us something for ear plugs!"

The cave was clanging and sirening with sound. We crawled to the top of the barrier. It was terrible.

The driven women came like a sea of flowers, limping, stumbling, holding one another as they fanned out into the great cave. Here and there one walked alone with blind ecstatic eyes. They fell, crawled, rose again, magically beautiful even in exhaustion. Around them the music was a punishing bray.

Then they reached the camp fires —and began to run, searching among the rocks, seizing the men's garments to their breasts, their faces. Some weaved in trance, while others pushed on, picking up and dropping even the sand itself as if seeking the trace of a particular man. The music was a pounding ache, relentless slow crescendo of sirens, bagpipes, drums.

Beside me I heard the old men gasping, their eyes aflame. Suddenly one tore the stopples from his ears and dashed over the barricade to the nearest women. They turned to meet him, arms wide and faces wild, and he went down under a wave of silk.

Pax suddenly gripped my shoulder. "My boys! My marksmen!"

On the far side of the wall there was an explosion of motion. Three —no, five young Flenn, their weapons flung to the rocks, their heads thrown back as they called. Then they were leaping down to the women, the women flying to them. But they did not fall as the wave met them—they gathered the women in armfuls, spinning on the crest of the terrible music. Five burning whirlpools in a sea of girls.

Behind us Flanya cried savagely, arched and writhing.

An old man pointed to the entrance. Three dark hulks—the Esthaans come to view their handiwork, not yet aware that the main body of the men had escaped. Then they saw. A signal flared, and the music died in reverberating discords. An Esthaan shouted, tiny and hoarse.

All over the cave the women had fallen in heaps. The Esthaan started down among them, kicking, as they converged on the pile of bodies around the Flenni boys.

The sight of those beautiful naked ones affected the Esthaans most horribly. Two turned aside, doubled and retched. The third marched upon them, unhooking a heavy whip from his belt, and booting at the nearest women.

The whip slammed down on the helpless bodies. The Flenni could scarcely rouse even under such pain; they whimpered and held

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each other. The Esthaan grabbed the nearest boy by the hair and dragged him to his knees.

"Where are the men? Where did they go?" he roared into the boy's face. The boy was silent, his eyes ringed with white. The Esthaan kicked him.

"Where did they go? Tell me!"

The other Esthaans joined him. One of them bent the boy back across his knee.

"Where are they?" the Esthaan thundered as the boy screamed.

It seemed important to what was left of my ISB indoctrination that Pax should not be charged with murder. Each of those Esthaans went down with two holes in him. As the echoes ricocheted we raced for the sobbing boy.

"Cover them, quick!"

We yanked silken stuff across the uniformed hulks and ourselves. I grabbed the boy, felt him go limp.

"They're coming! Keep down!"

We cowered, rigid, hearing the distant tramp above the soft breathing of the Flenn all around us. My field of vision included part of our rock barrier, and a Flenn lad, fallen between two girls.

We could do nothing but wait. I watched the faint heavy pulse in the boy's eyelids. And then I saw he was not only asleep, but was also changing. Luster was going from his skin, his hair. Under my eyes, the firm young flesh was paling, withering on his arms and hands.

His hands. I thought of the leaf-thin hands of the old man who had said, "Only this spring I helped open the Great Cave." The kits, the babies had been growing like hungry flames. In months the little child was a nubile girl. Did they die as fast too, once mated? So it was with the gamete-bearers among plants. This then, was the Esthaan weapon. I shuddered, seeing the boy's temples now sunken and blue. He would waken as an old man, waiting for death.

Boots came into my view. Two Esthaans by the rock barrier. I had set the old man to tapping out a signal which might serve as a beacon in the unlikely event that anyone cared. But the Esthaans would hear—

They had. As they started up the rocks, the old man appeared at the top, straightened, and called something. Then he was falling, on the Esthaans' guns.

"He said *safe,*" I hissed, grabbing Pax. "She's safe— Stay down!"

Pax nearly threw me as the Esthaans disappeared over the barrier. We heard crashing sounds. They reappeared, following the power-lead.

"If they fool with the pack, they'll blow us all."

But a new Esthaan shouted at the cave mouth, and the others trotted back.

"They've sighted the men."

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We had to watch while the whips were unlimbered and the women rounded up. The awful music crashed upon us. All over the cave, the exhausted women who had lain like the dead were rising painfully, beautifully, faltering to the cave door before their herders. A swaying river of bright flowers, upheld only by the dreadful stimulation of the sound. A lagging girl fell to her knees before a soldier, who picked up a rock and crushed her skull.

It was as the old man had feared. There was madness among those Esthaans who knew the truth. The soldier probably did not know what he killed, but his orders had come from those who knew—and could not bear it.

We were up and running for the rock barrier. The transmitter was a wreck, but Flanya was safe where the old man had hidden her. Pax carried her out, and I followed, stopping to straighten the old body by the barrier. At the cave mouth we watched the stream of colored silk passing from sight in the gorge below. The deathly throbbing died to silence.

"What do we do now?" said Pax. Flanya's eyes followed him like compasses.

"Well, we sit here and have something to eat, and wait. And we might pray to a god named Baal."

"Baal?"

"Or Moloch, if you prefer. An old god of material greed. We pray him to inflame the lust of gain in the guts of an old codger a hundred light-years from here—if he's still alive. If it flames up hot enough, we and the Flenni may survive."

"You mean the Federation Council?" Pax was irritated. "Or the Bureau?"

"The Interplanetary Survey Bureau," I told him, "may respond to our plea in time to help anyone who happens to be alive five years from now. The Galactic Federation Council is quite likely to respond in time to compose a documentary on an extinct race. Neither one can possibly move fast enough to help us mortal flesh now. The only agent who can do that is Captain MacDorra, and the only agent which can move MacDorra is cash. Golden Interstellar credits. And the only source from which such is possibly forthcoming is a human fossil, who, if he is still breathing, is squatting on the ninety-fifth terrace of his private empire on Solvenus. And the only motive which will move *him* is sheer cupidity and greedy lust to beat out another creaking reprobate basking by his private ocean on Sweetheart, Procyon. Hence, we pray to Baal.

"Luckily," I added as I saw Pax's jaw set, "MacDorra knows I have enough credits in my account to defray an ultrapho signal to Solvenus. Now, how about some chow? And you might rig out a beacon."

It took a little persuasion to make Flanya stay beside me while he went away. She nestled under my

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arm like a little silken dove, and when he went out of sight she put her hand on my arm and looked up worriedly. I saw she had a slight deformity of one finger. A defective gene, expressed because there was no companion chromosome to mask it. It was, of course, the existence of the haploid Flenni generation which made the diploid Esthaans so healthy—each time the pairs of Esthaan chromosome broke apart to form a Flenn individual, every sort of recessive defect emerged without an allele to temper it. Those dead kits and babies were filters which took out defective genes between every Esthaan generation. Cruel and beautiful mechanism . . . The quivering under my arm told me Pax was on his way with provisions.

When we had finished, I produced an item I had preserved.

"Can you find us a horn, or a banjo, anything at all to play on?"

He just looked at me, and then became very motherly. Our search turned up no horn or lute, so I showed him what a melodious banging could be made with a cookpot and a broken stirrup. He assented kindly, and we took up our watch by the cave mouth, me with my mouth organ and he with the pot.

We played softly, and Flanya seemed to like parts of it, which helped. I refreshed us on suitable parts of our repertoire, and began teaching him a stirring item called "British Grenadier."

I did not really expect anything to happen.

We jumped when the cutting flash came—the KA-BOOM-OOM! of MacDorra's emergency sled braking into air. MacDorra was a pioneer at heart, if his tightness had let him go it, and his emergency kit was First Landing T E and then some. It set down daintily on the mesa overhead while Pax and I scrambled up, he carrying Flanya and me carrying the pot.

MacDorra's mate, Duncannon, and four husky assistants were pouring out, guns ready.

"Where's the warr?" burred Duncannon. I could have kissed him, red beard, bazooka and all.

"They've captured the women and are marching them to their deaths," I replied. "Over there."

This had its effect on the mate; once it was settled who paid, there were no more gallant fighters in the galaxy.

"We saw something that could be that as we came in. Get in, boys."

"Have you a loud hailer?"

"I do."

"Then fly gently just before them and set down as close as you can."

We came on top of the pathetic army as they were struggling up the rocks toward another cave. It was nearly too late. The Esthaans had brought up reinforcements.

"That thing over there in the yellow suit is the enemy," I told

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Duncannon. "That gasbag is probably armed, and it shoots a gas that doesn't bother much. The game is to find the noise maker they have and silence it. Fire a flare when you have it stopped, I won't be able to hear you. Stay here, Pax, we have work to do."

I handed him the kettle and turned every dial on the hailer to output max.

I don't know what the Esthaans thought—those who weren't too busy with Duncannon's boys to hear us. I hate to think what we did to delicate Flenni ears. Pax got the idea as I crashed into "Sol-Sol-Solidarity", and came in with a thunderous beat—a walloping polka beat that had no more sex than a pig in clogs—a Donnybrook beat that could bounce a "Liebestodt" to shreds—a ragtime blast to meet and break that mesmeric Esthaan horror. We gave them "Interplanetary Heroes" and "Stars I'm Coming" and "My Buddy was a Bemmy." We blew and banged ourselves silly while Flanya cowered.

Duncannon told us later that our counterbarrage hit just as the first wave of women met and mingled with the men streaming helpless from the cave. Our uproar smote and clashed with the mad Esthaan hooting. As it took precarious control of the air, the Flenni mass shuddered. Couples broke, clung, broke apart—raced wildly, hands over ears—and the women began to drop. Finally only the men stood upright, their heads wrapped in their arms.

When the flare finally went up I slapped Pax's arm and we heard the last toot-bang of our "music" thunder across the hills.

"The only race in history ever saved with a kettle and a mouth organ!" Pax giggled. Then he looked horrified.

We shook hands hysterically and hugged Flanya. The hideous death of the Flenn boy mingled with Irish jigs in my brain, and I was not much help to Duncannon for the next half hour. We found him systematically hog-tying Esthaans beside the gasbag. Most of them were in rather poor shape. Our crew had only a few nicks apiece; ordinary ground-side armament can't do much against First Landing equipment in trained hands.

We sent Duncannon back to comb the line of march for survivors. MacDorra himself came down to oversee the setting up of a relief camp. It was a wonderful camp, with the ship's medicos and a plasma-synth and a nurse, and they worked like good devils. I noticed MacDorra had a little notebook in which he entered such items as the sled's fuel supply, the rounds of cartridge, and the number of disposable shrouds. He fed and ministered lavishly, his face a splendid blend of compassion and business enterprise.

The pitiful burdens Duncannon was bringing in upset the Captain.

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"Gurrrl children," he growled, motioning the doctor to open universal serum. He sniffed and turned away to make a notebook entry. I could see the Esthaans would be having trouble with freight rates.

The last load brought in the small shrouded figure I had feared to see. After a bit I carried my sleeping bag up to the mesa where the pink moons were rising over the floodlights below. A guard stood watch. Somewhere beyond the empty plain the Esthaan Council waited behind frozen masks. I knew they would do nothing now but wait. Somebody else would have to be assigned to unwind their madness; I could not.

Pax climbed to join me. The nurse had taken Flanya away from him.

"All right, Ian," he said. "Who is Santa Claus?"

"Ever hear of the Morgenstern Theory?"

"*That* Morgenstern? But is he still—?"

"And he still wants his theory of human evolution proved the worst way. I ran into him last leave on Eros with his dearest enemy, old man Villeneuve. Villeneuve thinks Morgenstern is a lunatic; he is heart and soul for the diffusion theory. Between them they're rich enough to buy the Coalsack, and they've been arguing this for years, financing expeditions, and betting fantastic sums. Well, Morgenstern took me aside and told me exactly the kind of thing he wanted to prove his theory. Instances of human development which could not possibly be interpreted as diffusion in Villeneuve's terms. He gave me a code word—*Eureka.* If I came across the right case I was to UP him collect at once.

"It came to me that the alternating generation setup here, shared by lower mammals and man, is about as close as Morgenstern can get to the proof he wants. It's not a hundred percent; there may be discontinuous mutation. But it's enough to give Villeneuve a very hot time. So I flashed him 'Eureka repeat Eureka,' and added that the evidence would be wiped out within hours by intertribal war unless he chartered MacDorra for immediate intervention and rescue. He may have bought the ship, or the whole freight line. You've seen the result. Sheer orneriness and ego—that's what saved us, son, not altruism or love of science."

There was a companionable silence. It was just dawning on me that I could take Molly's name out of the file marked *Widows.*

"What about the Bureau?"

"Well, that's where I may get reclassified to assistant jet-cleaner. There is a thing called an Irreplaceable Datum of Human Science. You may have run into IDHS areas somewhere—I believe one is on Terra. In the old training regs it says that any officer of the Ser-

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vice can declare an area, or species, to be an IDHS, and this automatically puts it under Federation protection until the case is reviewed and confirmed, or disallowed. The declaring officer has to present a formal justifying brief. It's a long business and it costs plenty. Almost never done any more; I think there's been only one in my time.

"I signaled the Bureau declaring the Flenni an IDHS in danger. This should eventually produce a Bureau relief team to take over from MacDorra. But it's going to be a sweet mix-up. Old Morgenstern is surely on his way right now with the idea that the Flenni are his personal pets—and in the Bureau's eyes he'll be just a meddling private citizen. I'm going to have a time seeing that the Flenni come out of this right side up and that I'm not thrown out of the Service for exceeding my authority, engaging in local warfare and native homicide, endangering Bureau relations, conveying Federation authority to private citizens, and general knavery. And I have a formal Declaration Brief to write."

IN TIMES TO COME

One of the things that makes an Editor's life fun is that rare delight of discovering a brand-new, top-notch author. It doesn't happen often. It's happened to me twice now in a few weeks—even though it will take more than half a year to show you the results!

Beginning next month, however, New Author #1, John Dalmas, will have the cover for Part I of his two-part novel, "The Yngling." The Yngling is a neoviking, born about a thousand years after our civilization collapsed. No—no WWIII. Just Nature taking her usual course. What do you think would happen if a new Plague came along that left only one in 10^{4th} human beings alive?

How long to recover? What sort of recovery would take place? And with a new ice age putting the squeeze on . . .!

But somehow the few immunes that survived the Plague seem to have tended also to have genes for psi talents—and when the right crosses occurred, in a by-then primitive world—well, what do you call such a person? One like the Yngling . . .?

The Editor

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"What do you call right side up for the Flenni?"

I sighed, remembering that Pax did not really understand yet.

"Well, tentatively, they should be protected in their efforts to maintain their own cultural identity, to extend their life span by deferring —" I caught myself—"to build an economy. There's probably always been a hostile tension between the two forms, since they are ecological competitors. The long-lived Esthaans had apparently shut the Flenni out of their urban technology by the time of First Contact, I suspect Harkness of having precipitated the acute stage. The Esthaans got the idea that the Flenni cycle was a dreadful defect which barred them from human status. They started out to conceal and minimize it, to ape human ways, and to reduce the Flenni to the status of breeding animals. Maybe it's deeper; the Esthaans have all the Flenn genes, and they may have some primordial drive towards sex which is impossible to them—and incarnated in the Flenni. At any rate, they're now acting out a full-blown social psychosis, and the engineers are going to have one grand job. But of course, biologically—" I paused.

"Go on, Ian."

"Well, you know it. The Flenni genes combine with ours. It's possible the alternating system is carried by recessives and could in the long run be bred out."

Pax was silent. Then I heard him catch his breath. I think it was the first time he had considered what his child by Flanya might be. Was it possible that this dove of a girl would give birth to a neuter sausage—an Esthaan?

"Don't you think it's time we turned in?" I asked.

"Yes," he said dully.

I lay gazing at the pink moons, thinking *Poor Pax, poor good retriever boy*. Interbreeding might eventually solve the planet's dilemma—but meanwhile, how many human hearts would go out to the Flenni beauty, the Flenni sexual impact? Only in dreams do we ever see beings who are literally all male or all female. The most virile human man or the most seductive ordinary woman is, in fact, a blend. But these creatures were the pure expression of one sex alone—electric, irresistible. How many of us would give ourselves to them, only to find the freely-given beauty dying in our arms? Whatever Pax's first-born would be, the arms that held it would be those of a dying crone—who only months before had been his blooming love.

The pink moons sailed the zenith, sweet as the gift of Flenni love. The image of Molly's face came finally to comfort me. Molly who could love and live, who would greet me among our children. I must remember, I thought drowsily, to tell her how good it was to be a diploid sporozoon . . . ■

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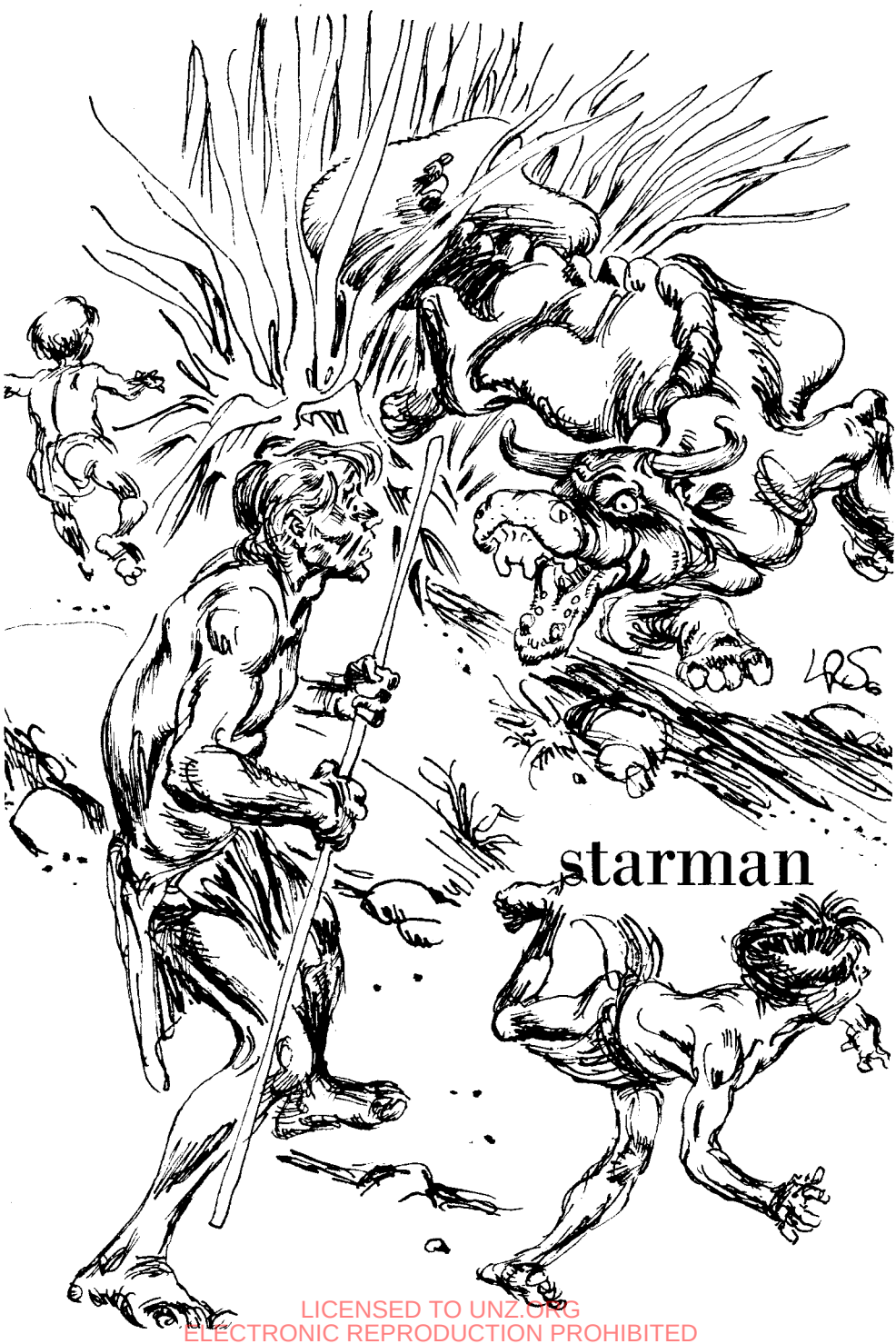

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A fool is one who doesn't learn how to make a living in his world. And that can make a fool of any traveler!

W. MACFARLANE

Illustrated by Leo Summers

"I want my freedom," said Dord Preble.

The Captain was sitting at a table in the ship's common room working at the cargo manifest with a cup of cold coffee by his elbow. He raised his bloodshot eyes.

"I'm signing off," said Dord. His voice was under better control. "I'm going to stay here on Kebrabasa."

"Ar-rah," growled the Captain and cleared his throat. "Go check in those gahdam nuts and watch it." He was a hulking man in a variable interstice jumper. "The wogs here get a little crafty—like all simple, innocent sons of nature." He snorted and bent over his papers.

The *Ethyl Purkheiser* was open to the atmosphere, but the common room held the smell of old boredom. There was the usual jumble of tapes around the reader, the Exec's carnivorous plants exuded halitosis as they bent toward the men, the bench was furred with scarlet dust and chips where Baldy, the engineer, was standing, and wads of sacar gum stashed under every table and chair gave off the ghost of spicy sweet aroma.

"Uh, Captain," said Dord, "don't you wanna know why—"

"Look. I'm notta shrink and I'm notta house mother." He wet his thumb and fumbled through a stack of pink flimsies. "The charter says you can jump ship on any rotten planet you like." He found the sheet he wanted and put it on top of the others. "The charter also says you take nothing with you. As a protective measure you come naked into any new world. You gotta be loved for your own sweet self." He weighted the papers with a cup and slopped cold coffee over them. He swore, and then looked up and grinned like a yellow shark. "I found your cache of food and guns and tools and clothes. You still wanna sign off?"

The Captain's jumper was smooth now, instead of tweedy. Dord ignored the accusation, which was true enough. "It's a question of individual conscience against the immorality of—"

"Uh huh. All you can take with you is whatcha got in your head. That's what the charter's about—open gene pool." He leaned forward in a horribly confidential way. "Dordsie, they got lotsa women here?"

"More than men, but—" Dord flushed. "I am leaving a depersonalized society where no man lifts a

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hand to help a neighbor, where—"

The Captain laughed coarsely. "Gnatpuckey." The red was fading from his eyes. He hated every morning of the world, but turned human as the day wore on. His variable interstice jumper looked like Oxford weave and he stretched luxuriantly before he pointed a finger at Dord. "I got two things to tell you, Preble. One, the righteous are always wrong. Two, go check those gahdam nuts!"

"Yes, sir."

Dord had crewed on the *Ethyl Purkheiser* for two years as Dizzy-boy and Watch Swab, and had been appointed acting fifth mate only a month before. A space tramp from an affluent world is everlastingly shorthanded. There were no second, third or fourth mates. He had been friends with the Captain, exercised hand-to-hand with him, learned chess and exchanged opinions—was it unreasonable to expect a little concern over his welfare? The Captain was an obdurate man. When Dord wondered at the grinding poverty on one planet and the unearned wealth of another, the Captain quoted, "Freedom means inequality," with a cynicism Dord found incompatible with his own concern for mankind. "You wanna do good?" the Captain growled. "When you learn to do yourself good, you can start doing good for others. Then you'll know better."

The Exec grabbed Dord's arm. "Getcher thumb outa your earhole. Here's the punch and tickets and open your eyes. The gooks got gnatpuckey grins this morning. The T-75's gotta busted circuit and you'll load by hand until Baldy gets her going."

Dord nodded and followed the loader around a lifeboat and down the ramp into the bright sunshine. *Ethyl* was on a ruined spaceport beside an ocean. Kebrabasa was a retrograde world like many others, where a civilization had wracked itself to ruin on the standard reef of irrational man in a technical culture. Broadcast power stations are usually destroyed by a visceral minority with simplistic yearnings for a golden age that never was, and the resultant chaos leaves an information gap impossible to bridge, almost as though curiosity had been burnt out of a people.

A small crowd of men and women had gathered around the tank. They were an easy, languid people and greeted Dord with smiles and little cries of pleasure. Children swarmed about and were shooed gently away. The first man emptied his net into the water and there was happy laughter as only a few of the nuts sank to the bottom. Dord counted them into the narrow end of the tank with a stick. He loaded the nuts into the bin—the T-75 usually did this job —wiped his hands and punched the

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number on the ticket. The delighted owner laughed like a child. The T-75 trundled back to the ship. Obviously there was something more wrong with it than the loading circuit, but Dord could not care less this morning.

A woman tugged his hand. She already had the ticket. Dord smiled and went over to the trade goods bin, where he handed out the items she wished to inspect. He wore the *Ethyl Purkheiser* kinship bracelet that neutralized the current protecting the cloth, needles and thread, ribbons and beads and buttons that interested the women.

All trade seemed inequitable to Dord. If you gave away these things in loving kindliness, the people would give them the nuts. The nuts were ridiculous, the fruit of a parasitic vine the size of a clenched fist. A needle-nose squirrel drilled into the mature nut to suck the pulp around the seed. A gahdam laid its eggs on the corky skin and a worm found its way through the hole. It plugged the entry, ate the seed over a period of months and metamorphosed into a mature gahdam.

It was an unremarked local curiosity until the Captain took a nut to Tredennick, which was seasonally plagued by fireflies. The gahdam abandoned vegetarianism and ate its weight in these pests every day and grew to the size of a flying banana. It could not reproduce itself on Tredennick, and made a handsomely profitable replacement item for Purkheiser & Gore, Importers.

The natives of Kebrabasa quickly discovered that it was impossible to tell by weight whether or not the nut held a gahdam. They drilled holes to provide the proper appearance and a large proportion of the nuts were blank. X rays killed the cocoons and the Captain had devised the float test. So far, floating the nuts had kept the natives honest.

They had extraordinarily good luck that day and the trade goods bin was almost empty by evening. The men wanted knives, plastic bows and arrows, broadleaf spears and hard blocks of sacar gum. Dord made his own list on the basis of their choices.

The Captain was waiting inside the hold. He had a fatherly expression on his face. "You better change your mind about going gook," he said. "You're not the worst fifth mate in the galaxy. You don't know a thing about primitive technology, and I am afraid these dearsy people will take advantage of you."

Dord was gratified by the expression of concern and offended by the callous disrespect for his friends. "I got your job done, Captain," he said stiffly. "I'll sign off now."

"And the wages you got coming?"

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"I'll take my pay in trade goods."

"Oh dear me," said the Captain, looking at the list. "Tell me, Dordsie, if you could have only one item, what would you take?"

"You owe me three months pay."

"Go ahead. Choose one, Dordsie."

He remembered the girls with the doe eyes. "The beads."

"You better take a loincloth instead." The Captain handed him a length of material. "Why do you think the T-75 was so slow today?" he asked. "I will tell you why. It was checking the nuts aboard ship —in fresh water. Your kindly friends filled the tank with salt water last night, Dordsie. Half the nuts you sent aboard sank in fresh. I took the difference out of your pay. You still want to sign off?"

"Uh . . . those poor exploited people—" began Dord.

"You're up to your eye in gnatpuckey. Sign here."

Dord scrawled his signature, stripped off his jumper and stalked down the ramp.

"Gimme the kinship bracelet," said the Captain. "We can't have you wogs sneaking in and stealing stuff."

"Take back your badge!" Dord shouted incoherently, and threw it at the grinning Captain.

Until he turned native on Kebrabasa, Dord Preble never had much interest in languages, food production or walking. All civilized planets used Interlingua as a second tongue, farming was a specialized discipline and walking was an idle pleasure.

He found the language of the People unbelievably complex. They had individual names for each flower and bush and tree. He kept track of the number a young boy pointed out to him in an hour and quit in despair when the count reached forty. The food consisted of a gritty kind of biscuit, wild vegetation, and the internal organs and muscle tissue of animals slain haphazard along the route of march and lightly toasted over an open fire.

Dord began travel with the young men. They moved through the overgrown landscape like shadows. He was lost twice before an impatient little girl found him and dragged him to a group of preadolescents who took care of him for the rest of the journey. They called him "Starman," showed him how to keep his loincloth on, and were amazed at his stupidity.

By observing the children closely, at the end of four days travel through tumbledown cities and untrimmed wilderness, he was not damaging himself as often as he had in the beginning. His stomach was still doubtful about the diet and his feet were cut and bruised, but he learned to drink water running over the ground, he learned

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to avoid shrubs covered with needles.

The home base of the People was at the side of a large bay beside a stream. Dord was astonished that home consisted of rubble huts under the trees, hide canoes hauled onto the bank, and more or less uniform vegetation in patches on the alluvial soil. He had been anticipating a hot bath, a meal in a good restaurant, and a desk job in a controlled climate office. He had seen primitive dwellings on other planets, but assumed they were quaint tourist displays, and when *Ethyl* departed, the people went back to their cities and lived like human beings.

He was in a state of shock when they entered the village. The old women, who stayed at home, had prepared a feast of gruel and meat and beer. The beer was sour, slimey and powerful. Everybody got roaring drunk. Dord woke the next morning with shattered vision, a slop-sump mouth and jagged memories of a stomach-churning orgy.

His eyelids creaked like rusty shutters. The smell of burned bones and old beer curled queasily around his nose. With sudden brutal clarity, he realized he had been drowning in data—not rationalizing. He was a licensed idiot and the People had shown him remarkable charity, possibly for the sake of the amusement he afforded. He was a walking measure of their superiority over the tin can fools who appeared from time to time to be swindled with gahdam nuts in exchange for items of real value.

"Ee-oo, Starman! Come play!"

He made a tremendous eructation and his eyes bugged out as one of his peer group, about six years old, sat on his stomach. He almost died. The most courageous act of his life followed: he rolled over, got to his hands and knees in spite of the lurching earth, and crawled off in dogged search of self-improvement.

He graduated from being kindergarten fool a few days later. He and the other children were gathering seeds. It was customary to cup a large leaf under each pod and tap the seeds into it. Dord armed himself with a long stout stick, and with a child at each corner stretching his loincloth under the bushes, he beat the pods until the seeds rained down. This feat put him into the dullard adult class.

He was promoted to brave oaf and allowed to live among the young men after he killed the beast. The People had many names for each animal. This one was called Ugly-fire-eye and Squatty-slasher and Quick-roarer. It was omnivorous and had lateral horns. Dord whacked it with his stick. It was the last thing he intended to do. It burst, snorting, out of the bushes.

The children dropped the cloth

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and swarmed up trees. While Dord stood stupidly watching, it wheeled and charged him like a rock falling. He braced his stick against a tree and raised it as the beast opened its mouth to roar. It skewered itself at precisely the proper angle not to break the stick and thrashed for ten minutes while he smashed its head with a rock.

Joining the young men introduced him to the mysteries for which they were in training. There was an inferior breed of man pretending to be People living across the bay. They had no morals. The only rational thing about them was the custom of sending their young men to the island in the middle of the bay at the conjunction of the moons. There was a fountain on the island and it had been determined that drinking the water assured good hunting and good crops during the coming year. As soon as the moons touched, the young men went to the island to secure the fountain for their people. The entire population followed when the moons separated again and whichever group held the fountain got to choose wives from the others, and everybody joined in a ring-a-ding orgy.

Dord was brought into the training program a little late. As an archer, he could always hit the ground. He was merely inept with a knife. With a spear, he could stab a tree. At skulking and stalking he sounded like a man eating celery. At traps, deadfalls and devious devices he was a textbook example of the perfect victim. His ability at unarmed combat was unassessed, because who is foolish enough to fight unarmed?

There was another educational deficiency of which he was not aware until he was paddling his canoe over the moonlit water toward the island. He was a fool in a boat. If you paddled on one side of the thing, it went the wrong way. If you paddled on the other side, it went the wrong way. He missed the island, and it was only the abnormal eddy of the tidal flow that allowed him to land on the seaward side, alone, shipwrecked and desperate.

The conjunction lasted three days. During that time the Pretend Men would do their best to kill the Real Men. Right now a pair of slitted eyes might be watching, arrow nocked with easy expertise, waiting for him to stand and make a better target. He had lost all food and equipment. Soaked in salt water, battered by his landing, the peril and frustration of the situation overwhelmed him.

He shouted in outrage and terror. He ran shrieking through the beach rocks, scrambled wildly up a low bluff and into the dark shadow of the trees. He did not stop until he was hit a savage blow on the head.

It was full daylight when he re-

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gained consciousness. His eyes were sealed and his body constricted. He groaned and writhed off some implement of torture grinding into his back. He lifted a trembling hand to his head. His eyes were covered with a thin painful glue. He spit on a finger and worked one eyelid loose. There were leaves above him and rough walls on either side. Tears seeped from his eyes and helped the ungluing process. It was a long time before he realized that he had run into a low branch, knocked himself silly, and had fallen between two giant roots of a tree.

There was a slanting gash on his forehead and his eyes and face were crusted with runnels of dried blood. He grinned tentatively when he remembered a phrase the Captain used, "I oughta knock a little sense into your head," because a tremendous burden had rolled off his shoulders during the night. He knew exactly what he was going to do. He was going to steal a boat, get off the island and camp at the old abandoned spaceport until he could hitch a ride away from this stupid planet.

For the first time in his life, Dord Preble wanted something with a calm unquestioning passion. If the natives wanted to sit on rocks, that was their hard luck. If they enjoyed sour snake-spit beer, let 'em. If they chose to bathe in raw water inhabited by wigglers, he would choose a steamy bathroom, which is surely the closest man comes to paradise in this life.

The first step in the direction of the bathroom was to look around for danger. There was a flick of movement in the bushes—a needle-nose squirrel. Next? Head for high ground and survey the siutation.

Dord skulked in a way that would have made his mentors proud. He moved with great patience. He kept to the shadows and followed a gully up the hill. He crept along a crumbling wall and peeped around the corner. His ears ached with the intensity of his listening. When the ground leveled ahead to a ruined concrete installation on top of the hill, he sneaked laterally below the crest to avoid silhouetting himself.

He had climbed from the seaward side of the island where the hill rose most abruptly; the bay side sloped to a plain covered with overgrown ruins. Below him was an irregular, open square, and in the center a shaft of water was blown by the wind, tumbling back to a large reed-grown pool. Dord was suddenly conscious of an overwhelming thirst.

Thirsty? Go get a drink. He started to walk downhill.

Phizz-oo! An arrow whistled over his shoulder. It rose into the sky and cut an achingly beautiful arc before he lost it against the trees far below. He jumped sideways just in time to avoid interrupting the beautiful flight of an-

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other arrow. He rolled into a thick patch of overgrowth, scrabbled sideways toward a tree and dove over a low cliff when a third arrow quivered miraculously in front of his nose.

He wriggled into the cover of vines and bushes. He crawled silently to the base of a concrete wall. He crept along until he came to a vine-blurred indentation. With desperate caution, he eased through the vines and under a tangle of needle bushes. Expecting to meet a wall every instant, he crawled his own length and his own length again. Looking back, he could see the rough rectangular outline of the opening. He edged back farther until his passage was blocked by a slide of rubble.

A man with a spear was outside. Dord began to climb the slide and a rock rolled to the floor. The man prodded the spear through the covering vines and leaped crouching into the cave.

Dord hurled a rock as the man dropped to the ground. It grazed his ribs and he twisted like a snake. Dord hit his shoulder and spun him around with a second rock. The man burst out of the cave through the screen of vegetation.

"Cowardy - cowardy - cowardy!" screamed Dord.

There was a brooding silence. Dord sank back onto the rock pile. He sorted missiles and chose a dozen rocks with particularly sharp edges. He was watchful though his eyes felt dusty. He slumped into a comfortable niche. Then he waited. He blinked his eyes. The sky was thin blue outside. He waited.

"You're a hero, Dord Preble," said the Captain. "You have proved that a civilized man is more than a match for an armed gook. I'm proud of you. You have applied reason to a tough situation. You're sharp. You're alert . . ."

He woke in a panic. There was a band of lemon-yellow across the evening sky. He groaned aloud. He was a mass of bruises and cuts and abrasions he had not noticed in the heat of action. He was stiff and chilled. He was sure of one thing. He was not going out of the cave. Not until deep night. Perhaps the fog would come in, wet, wonderful moist fog. He swallowed raspingly and shuddered. It was not right that he should be so cold and so thirsty at the same time.

The roof of the cave was well above his head. He climbed the rock fall and felt a breeze on his face from a hollow under the roofline. He excavated rocks and wriggled through the opening. He was sliding down the other side before he wondered about bottomless pits. A rock gouged his thigh when he rolled onto the floor. He whimpered and laughed at the same time. With his arms out he could touch either side of the cave. He tested each footstep in a dark so black that he closed his eyes to re-

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lieve himself of the strain of trying to see.

He lost contact with the right side of the cave, stumbled and hit his battered head against a wall. He slumped to the floor. This was the end. Fresh blood crawled down one cheek just in front of his ear. He was trapped. His bones would rot here. His head was in a corner and in wild protest he literally kicked against fate, and his foot touched nothing.

Suppose the cave had turned? Suppose he was a stupid idiot? Suppose it wasn't a cave?

In the dark of night, in the blackness of the tunnel, in the blindness of unexamined assumptions, Dord Preble's world was miraculously illuminated. Not with light, but with the faint dawn of understanding. He had been isolating facts again. He was thirsty, go get a drink. It had nearly killed him. He had despaired when he knew all along that Kebrabasa once had an advanced culture, and that caves do not have smooth walls and floors. This thing was a tunnel, and it turned.

He got slowly to his feet and followed the tunnel without fear. Understanding is a heady thing and he was obsessed with his discovery: "Facts are in context," he whispered to himself, not even considering the possibility of a false dawn. This truth was so enthralling that he forgot his weary body until the floor became uneven and he saw the dimmest sort of opening ahead. "Very carefully now," he whispered, and crept forward.

He was in the open, all right, but there was only a ragged circle of stars overhead. He was at the bottom of a well. The top was overhung with trees and the walls were vertical. He was still in the earth, fifty meters down, and there was no way out. He stumbled wearily into the center. The passage of years had littered the bottom with dirt, dead branches and piles of leaves. There were bushes and grass growing more than waist high. He shivered in the wet.

Water! Where?

He licked a leaf and cut his tongue on a serrated edge. He swept his arm through the grass and sucked the dirty salty water. He stopped this frantic activity but could not control his convulsive throat. This water was condensate from moisture laden air, caused by a temperature differential. "Don't isolate facts, associate!" he croaked.

He ripped off his loincloth and shook away some of the dust and dirt. He soaked it with dew and twisted the cloth to wring the water into his mouth. The well was about ten meters wide and he covered it all before his thirst was quenched. He discovered an indentation in the wall on the far side of his entry point and the leaves were thick there. He bur-

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rowed into them when his belly sloshed with water. "Cold and beaten and starved and trapped," he shuddered, and the new Dord answered, "Shut up, stupid. Wait and see—get facts—can't see in dark—when there's light . . ."

He woke grudgingly and opened his eyes. When they focused, he saw a broadleaf spear a meter from his chest.

He erupted in an explosion of leaves. He was at the other side of the well before his mind caught up with his body. The spear was in the hands of a skeleton. When his heart slowed to a gallop, he went back to examine it. A man had died there and his bones were gnawed by insects. Both legs were broken and this encouraged Dord. The skeleton had not been healthy. Surely there was a way out for him. Of course there was. The way he had come.

He took the spear and reversed it. The wooden shaft clanged on the back wall. That meant the man had been here for a long time, because the staffs supplied by the space tramps were made of fiber glass. He walked across the grass to the forbidding entrance to the tunnel before he wheeled and ran back.

Rock does not clang. The back of the skeleton's hole was metal. It was a double door, the bottom covered with dirt. He scraped it away. It was dogged on the edges with unfamiliar wedge and ratchet fasteners. Their purpose was obvious enough and there was a rewarding thunk on the inside as he undogged each one. He took a deep breath and pulled on the handle. Nothing happened.

Perhaps a gasket had seized. He pounded the edges with a stone and pulled again. No movement. He ran the spear shaft through the handle and tried to lever it open. The wood creaked and he stopped pulling. The handle was a flattened circle mounted on a round base and it occurred to him that it might turn. It did, with the help of the spear shaft. It turned 90° to a horizontal position and the doors grated open to reveal a small room, three meters square with a door in the far wall. He opened it and found a rock pile immediately inside. He turned to the room. There was a bench with a gripping devise at one end, there was a shelf with canisters, there were inexplicable tools on one wall and another was covered with what appeared to be plumbing hardware. On the floor was a wheeled platform with a meter-high railing and a corner control shaft. Over the railing hung a pair of coveralls that broke in two when he lifted them.

His throat choked and he blinked his eyes. He felt a kinship with this vanished people he had never known with their descendants. They had built the cities and time en-

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trapped, here was a place he could feel at home. Here was the mutual effort civilization demands, the order and precision that makes man free through the interdependencies of technology, rather than chaining him to his individual ability in a hunt for food, shelter and safety.

Dord ran a wistful finger along the smooth metal of the platform. There was not much dust. This was something he could almost understand. It looked like a lifter, like those used to clean windows. Usually there were magnetic strips in the buildings as guides. The little G-null motor ran on broadcast power or was self-contained with batteries. Those Dord knew carried water and brushes and squeegees to do the job automatically.

Nuclear batteries have a long life.

And he would make a nuclear battery out of grass and branches and rocks? He dragged the platform into better light. It ran on swiveled wheels and there was a flat place on each wheel. The top of the platform was dimpled for traction, there were clips on the stanchions to hold equipment fast, and the sides were unbroken by projections or fasteners. He tipped the platform and found a plate on the bottom. It was sealed with a compound as hard as the body itself. He admired the technique. The sealing material was vulnerable only to its designed solvent. The parallel with his own technology was exact.

He set the machine on its wheels again and examined the control column. There was a panel on the inboard side with a finger indentation. It swung up and out, hinged at the top. There was a reel inside and a slot. No place for a battery, no terminals, no wires, nothing he understood.

The top of the control shaft was incomprehensible. There was a finger pull at one corner and it opened to form a small funnel. He probed the hole with a stick and found a shallow tank, as mysterious as the knurled wheel or the transparent slits marked in an unknown notation.

He was starving to death.

There was only one way out, through the tunnel passage. In a spirit of homesickness he ignored his hunger and returned to the room for a more careful examination. He could understand a hammer, but what was that thing with the double shaft? The tools were as alien as the results were one step from familiar. He solved the wedge closure tops of the containers quickly enough, but did you rub the yellow gloop on your head or on an axle? Were the various powders and granular substances food or cleaning compounds? And the heavy rolls of layered paper in the round canisters, what were they for?

He had an answer to this ques-

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tion almost immediately. The dim light grew dimmer. A Pretend Man peered into the room. He held a spear, a bow was slung over his shoulder and he carried a knife in his other hand. Dord threw the roll of heavy paper at him. The edge of the canister hit his forearm. The man howled, dropped the spear and bounded at Dord, his knife waist high.

Dord struck his wrist aside, chopped his neck, stepped on his foot and drove rigid fingers into his diaphragm. The knife clattered to the floor and the man writhed on top of it. Dord kicked him away and picked up the knife. He slashed the bowstring. He heaved the wretching body onto the platform. He lashed his elbows together behind a stanchion.

There was a soft sizzling noise. Dord whirled with the knife awkwardly ready. The paper had unrolled on the floor and bubbled where the Pretend Man had vomited onto it. His captive began to howl and Dord clouted him impatiently.

That stuff looked like—seemed to be—it had to be "battery" paper. It was made of a layer of zinc paper—or was it magnesium?—treated with common salt crystals, with another layer of paper soaked with potassium persulphate and powdered carbon. Dampen the paper and current is generated. You get a flat discharge curve, high power density and long shelf life. Maybe a very long shelf life. Dord grinned crookedly.

He hit the palm of his hand with his fist. A G-null motor is not greedy for power, nor did it depend on complex mechanical relationships. In his own technology it had six moving parts. The ancient Kebrabasans might have seven if you counted the reel. He dragged the platform and his captive into the open. He loaded a dozen canisters of paper onto it. He put the two spears aboard. The knife was tucked into his loincloth. Unfortunately, the Pretend Man carried neither food nor water. He was silent now, following Dord's every movement with hate-glazed eyes.

Dord opened a fresh roll of battery paper, loaded it onto the spindle and fed the paper into the slot. He shut the panel and took a last look around the well. He still had no idea of its purpose. Why would anyone build a hole in the ground like this? He could still go out the tunnel. What was he waiting for? He ducked under the railing and shut the double doors to the storage room. He marched back to the platform and turned the knurled wheel.

Nothing happened. He moved it farther. Still nothing.

The platform had to be a lifter. It was the right shape, just as a water tumbler is the right shape for a human mouth all over the galaxy. If you want to inspect the

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sides of a well, the best way is with a free lifter.

The paper had to be battery paper. Dord had made it himself. It was a good education tape. The details of the sandwich were plainly diagramed and he had all the chemicals in his school kit. He had made a 6 x 8 centimeter wafer. He moistened it with distilled water and . . . there was a funnel on top of the control panel.

The only water he had available was not exactly distilled. He hesitated. The organic salts might raise hell with the reaction. He could collect dew. He could fill the tank. He could wait until night—he could not wait.

With water in the tank the platform stirred. The prisoner yelped. Another turn of the wheel and the platform lifted off the ground, rising easily, drifting toward the wall. The Pretend Man moaned until his ululating howl reverberated. Dord kicked him and pushed off the wall with his foot.

The platform drifted to the surface in the center of the well and continued to rise. Dord caught the tip of a branch, but a gust of wind left him with a handful of leaves. He could not complain. The sun and the wind and the safety of the sky, a machine to deal with instead of primitive technology, all these things made his heart light.

It thumped wildly in his chest. Was the wind blowing toward the sea or the land?

For a panic-stricken minute he was disoriented. He could see nothing but the ocean. At that moment the Pretend Man slashed his legs out from under him. The hard stabbing feet smashed on his head and shoulders. His legs were over the edge. He grabbed an ankle and was kicked off the platform. He dangled by one hand. He grabbed the bottom of the stanchion with the other and pulled himself up. His belly and chest were rubbed raw. The Pretend Man was stretched on his back as far as he could, still held fast by his elbows. His feet could not quite reach the other rail. His eyes were mad and he was howling again.

Dord stepped on his stomach and flexed his knees wholeheartedly. The howls stopped. With a firm grasp on the railing, Dord saw they were drifting over the island. His footing was soft and unstable, but very satisfactory. The platform was following the contour of the ground, perhaps one hundred meters up. He did another knee bend and indulged in the luxury of idle speculation; what sort of regulating mechanism would still work after this length of time?

Once again the captive distracted him. The man was straining forward to snap at his leg. Dord stepped off his stomach and the man twisted convulsively. He got his knees under him and threw his body sideways off the platform. He hung by his elbows and howled.

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"Give your neighbor a helping hand," said Dord between clenched teeth. The knife was still at his hip. He slashed the bowstring. The man fell spraddling through the air, still howling, and splashed into the fountain.

Three days later, Dord Preble slipped through the screening trees onto the crumbling spaceport beside the ocean where the *Ethyl Purkheiser* had set down so many days before. He was a dirty, scarred and ragged figure, but he walked like a man with some confidence in himsellf.

The platform had carried him across the bay and over the village of the Real Men. The wind was variable and he cranked up to one thousand meters in search of favorable air currents before the platform faltered and the transparent strips edged toward black. His supply of water was failing. The platform was almost in a fall before he managed to splash a little more into the tank. Then the wind changed. He landed and moved from landmark to landmark through the trees and tumbledown cities. He grubbed for roots and beat seeds from the pods onto a leaf and found they were inedible raw. They had to be parched and he had no way of making fire. He escaped a squatty-slasher by climbing a tree. He ate an immature gahdam nut, which made him sick.

He walked directly to the lifeboat sitting on the spaceport and slibbered the latch. He was beyond surprise, now and forever. He sank into the pilot's seat with a sigh of pleasure. The boat smelled of machinery and exotic cargo and wonderful stale air. He tapped the liquid crystal panel and it lit abruptly.

The Captain grinned at him. Wherever the *Ethyl* was, it must be late in the day. "You took your own sweet time," said the Captain. "I was about to recall that boat. We haul offa this crumby planet in a couple of hours."

"Yes, sir."

The Captain's grin grew wider as he took in the scarred and battered Real Man. "Well, Dord," he said, "I will tell you something. Space is dull and dangerous—a helluva combination—and the Exec and Baldy and me, we've all gone gook in our time. While we've been potzing around picking up cargo, we figured you'd make it awright, but you cut it a little fine."

"Yes, sir."

"The lifeboat is homed on *Ethyl.* Shove off and get over here. You're full fifth mate now. There's work to be done." He paused and then chuckled. "Did you have a good time?"

"Yes, sir," Dord lied stoutly, "but it's nice to be home." ■

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From the look of things now going on in Russian astronautics—anyone wanting to move to Mars will have to learn to speak Russian!

by G. Harry Stine

THE BIG BOOSTERS OF THE U.S.S.R.

(Author's Note: This is a follow-on article to "How The Soviets Did It In Space," published in the August 1968 issue[1]. Again, no classified sources have been used for this article. Information sources are in the public domain, and all technical speculation herein resulted from calculations made from equations and formulae available in most astronautics handbooks. The analysis, synthesis, and opinions expressed herein are the total responsibility of the author and do not necessarily reflect those of any other organization with whom he may be affiliated.)

"The earth is the cradle of humanity, but mankind will not stay in the cradle forever."

Those were the prophetic words of the Russian schoolteacher from Kaluga, Konstantin Edouardovitch Tsiolkovski. They were written long before the sputniks began beeping their pioneer paths through space. To the citizens of the Soviet Union, these are "holy" words from their patron saint of cosmonautics —"holy" because the field of cosmonautics has taken on all the trappings of a religion in the Soviet

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Union, whether by state design or by accident. This emotional-spiritual involvement with space flight may sound childish and "unsophisticated" to our Western ears, but it is an integral part of the sustained fifty-year romance with space flight that has gone on in the Soviet Union[2].

There are other reasons, too. The space "firsts" of the Soviet Union are cherished because it insures forever the place of Holy Mother Russia in the history books of the future. From the political point of view, the Soviet leaders closely identify Soviet space achievements with the prestige, growth, economic might, and creativity of Soviet socialist society. There are also military implications, but it is not at all fashionable to discuss such things in Washington, and Moscow doesn't breathe a word about them, either. Be that as it may, a large percentage of astronauts/cosmonauts are military men, and many of the space launch vehicles have been directly modified from military vehicles—but this is in concert with both aviation and marine technological history.

The history of the Soviet space program has been documented here and elsewhere.[1,2,3,4] But the very nature of the slavic-tartar mind involves secrecy; whether this is due to a general mistrust of the rest of the world or a cover for a massive inferiority complex is debatable. Therefore, those of us who are not privvy to classified Soviet intelligence reports of CIA, DIA, and other U.S. intelligence agencies can find ourselves pretty much in the dark when it comes to future Soviet space plans. But a great deal of this can be eliminated if one simply takes the time to read and digest the constant stream of information that flows westward from Pravda, Isvestia, Trud, Tass, various foreign news agency releases, the British Interplanetary Society Journal, and the activities within the International Astronautical Federation (IAF).

A [illegible] of Soviet space [illegible] reporting by A. Zaehringer, Don Ritchie, Dr. Charles [illegible] Sheldon II, Dr. Albert Parry, the author, and others, some interesting patterns begin to emerge.

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Sometimes, interesting photos slip (?) out of the U.S.S.R. This photo was in the Novosti Press packet available at the 1967 Paris Air Show. It shows cosmonauts having a celebration with a cake. Left to right: V. M. Komarov, V. F. Bykovskiy(?), V. V. Nikolayeva-Treshkova(?), B. B. Yegorov(?), and Yu. A. Gagarin. Are the two rockets on the cake models of the Soyuz launch vehicles? An artist air-brushed a possible interpretation in the right photo. Is it really a clustered vehicle? Was this a cosmonaut party held before the initial Soyuz mission with five cosmonauts that were to go up in the first two Soyuz capsules and perform docking and transfer back in April 1967?

Firstly, the Soviet Union apparently has three distinct goals in space. These are long-range goals that may require decades to accomplish. They have pursued these goals with a resolute adherence to objectives despite many failures; this unwavering conformance to "The Plan" may be nothing more than a consequence of the monolithic nature of the Soviet bureaucracy, but it is there nonetheless. These three long-range goals are different, require different levels of technology, and yet are sequentially dependent and, therefore, syner-

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gistic in nature. They may be briefly prefaced by the general goal of Soviet cosmonautics in the exploration, exploitation, and colonization of every celestial body in the Solar Systems upon which they can land and survive with technology. The three sequential goals are:

1. Establishment of large, multimanned, continuously-operating facilities in orbit around the earth.
2. Exploration, basing, and eventual colonization of the Moon.
3. Colonization of the planets, moons, and planetoids of the Solar System.

These have been listed in the order in which the Soviets have probably established priority.[5]

Justification of the forecast of colonization intent is simple: The Soviets are training female cosmonauts[2] (or "cosmonauttes"?) as well as male space pilots; this is not so much an expression of the Soviet sexual equality concept as it is a realization in reality that the male of the species cannot, alone, colonize—biotechnology notwithstanding between now and the year 2000!

Secondly, the Soviets have revealed and steadfastly followed rigorously one particular development and exploration philosophy with respect to space accomplishments. This may be briefly summarized as consisting of (a) unmanned instrumented probes, (b) unmanned automated test operations and, (c) manned automated test operations. When man finally does get into the spacecraft, he is far more of a passenger than in American craft. Whether this reflects a Soviet mistrust of a man's abilities, a reliance on machines in preference to man, or simply unswerving adherence to A Plan established years ago when it was believed, both in the U.S.S.R. and the U.S.A., that manned spacecraft had to be fully automatic because of the bioastronautical unknowns. (Glenn's "Friendship-7" Mercury capsule was far more automated than an Apollo spacecraft currently is.) The Soviet Vostok and Voskhod programs were characterized by this philosophy; so is the Soyuz program with its fully automated docking capability. The Soviets also have a propensity for putting a system through its paces with animal passengers before committing human beings to its operation; for these, they prefer to use dogs because they have better baseline data on dogs than monkeys, exactly the opposite of researchers in the U.S.A.

Another pattern that has emerged is the fact that the Soviets have never lied about their space program. This blunt statement has drawn rabid criticism from many persons who believe the entire Soviet program to be a hoax; by the same sort of twisted reasoning, one could claim that the entire U.S.A. program is a TV special-effects spectacular done with models and pre-recorded scenes shot on loca-

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tion—after all, how many Americans, who have actually watched the astronauts climb into those spacecraft, are positively certain that the rocket did take off and go where it is said it went, et cetera, et cetera? Therefore, if one carefully studies the public statements of Soviet scientists, cosmonauts, politicians, and news services, one should be able to piece together a very rational, reasonable Soviet plan using good old private-eye techniques that every Mickey Spillane reader knows quite well. And, hurrah, it can be done by simply comparing Soviet statements against Soviet performance during the first decade of the Space Age. (Sure, some statements missed the mark, but even U.S.A. space spokesmen don't bat 1,000, either!)

Granted that some Soviet statements have been exceedingly vague. But vagueness is almost inherent in the Russian language and, therefore, also in the way a Soviet spokesman expresses his thoughts. A statement which, to a Soviet listener, explains a great deal may be totally obscure to a Westerner who is used to receiving very frank answers of highly concise information content. Some Soviet statements have also suffered in translation because even the most objective translator can bias a statement by the choice of words he uses to express the idea. Anyone who has ever studied another language can attest to this sort of translation problem. My own experience with similar problems has involved the drafting of international model rocket sporting rules for contests, and I can personally attest the fact that it is difficult to get abstract ideas, or concepts, expressed when speaking a language not your own, or when trying to communicate with someone for whom English is not a native tongue.

Can we come up with a reasonable forecast of future Soviet space achievements?

A reasonable attempt can be made if we study what the Soviets have said about what they intend to do and if we take them at their word—tempered with some knowledge of their past performance, a knowledge of their basic economic system, and some engineering pragmatism. (The Soviets, incidentally, are eminently pragmatic when it comes to space technology.) Such a forecast is probably an optimistic one . . . but an optimistic forecast is often preferable to a pessimistic one that could lead to being "sputniked" again.

In an article entitled "Manned Space Stations" in early 1964, Major General Nikolai L. Kamanin, Commander of the Cosmonaut Detachment, and I. N. Bubnov[6] laid out the following program for the Soviet Union:

1964-1965: A "soft" landing on the Moon of an automatic station.

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FIGURE 1. SPECULATIVE USSR "D" LAUNCH VEHICLE

Payload: 30,000 lb. to Orbit

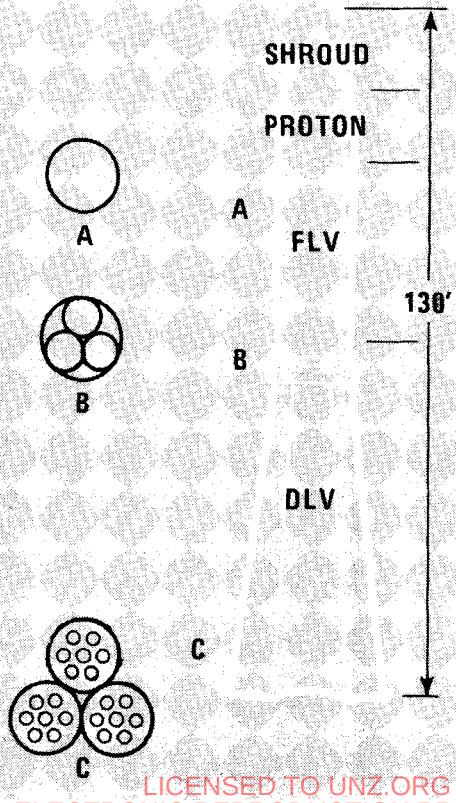
FLV

Thrust: 600,000 lb.
Gross Weight: 327,000 lb.

DLV

3 Megapound Modules
Thrust: 2,500,000 lb.
Gross Weight: 1,523,000 lb.

Base Diameter: 33 ft.
Lift-off Weight: 1,880,000 lb.



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1966-1967: Flight of a manned spaceship around the Moon.

1967-1970: Building of a manned space station with a crew of three to five men.

1968-1970; Landing of a man on the Moon.

1972-1975: Building of a larger manned space station with a crew of thirty to fifty men.

1975-1980: Flights to Mars and Venus of a manned spaceship with return to Earth.

1980-1990: Landing of Men on Mars.

They further state that this forecast is speculative and probably pessimistic, that "the successes of Soviet cosmonautics often outpace even the most optimistic plans . . ."

How well did they forecast things that have happened thus far? Luna-9 "soft-landed" on March 31, 1966, which is about a year behind the Kamanin-Bubnov forecast—and a "soft landing" to a Soviet space technologist probably is any landing that the measuring instruments will survive. Their circumlunar flight is already late, although there are strong indications that it was originally scheduled for launch in early December 1968, about a year late. However, if you count Soyuz-4 and Soyuz-5 as the prototype of a "manned space station with three to five men," they are right on schedule. The manned circumlunar flight is likely to go in 1969, although I am personally calling the shots a little close on this one because it won't be taken as a forecast, but as a prediction. If we generally slip the Kamanin-Bobnov forecast by one to two years—a slippage probably created by the ill-fated Soyuz-1—we might get some good idea of what the future holds.

To carry out this program, the basic ingredient is a "stable" of launch vehicles.

Soviet Academician Leonid I. Sedov stated in an interview in October 1968, "The existing rockets and spacecraft that are now available are capable of carrying out a manned mission to the Moon . . . The existing rockets are now quite adequate to power a number of lunar and planetary space explorations. Unquestionably, in the future there will be even larger rockets." Back in March 1968, Sedov[7] said that the carrier rockets for the manned lunar landing missions "have already been constructed" but that "the question of the return to Earth is very complicated and requires quite a lot of preparatory work."

If these carrier rockets already exist and if the Soviets intend to carry out a 1970-decade space program along the general lines forecast by Kamanin and Bubnov, what do the Soviet launch vehicles look like, how big are they, what are their capabilities, and when can we expect them?

In order to discuss the Soviet

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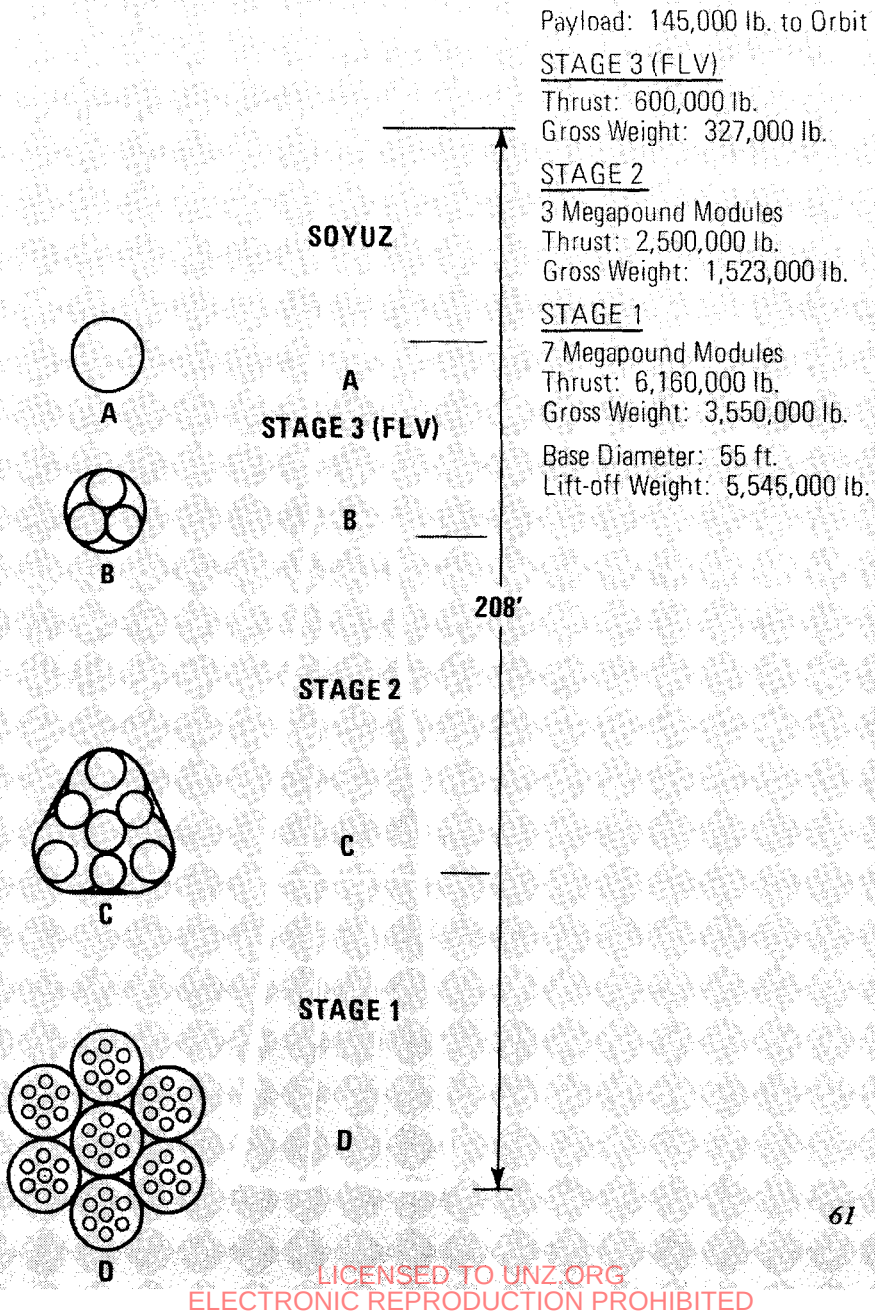
FIGURE 2. SPECULATIVE USSR "E" LAUNCH VEHICLE



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launch vehicles, we need some agreed-upon standard of designation or nomenclature because the Soviets have not supplied it and there is no indication that they use a consistent system of designation. There has been considerable confusion generated in the western nations because of the lack of a standard system of designation for Soviet launch vehicles. Dr. Charles S. Sheldon II of the U.S. Library of Congress, one of our foremost Soviet "space watchers," has come up with an excellent system,[8] and I will use it herein with a plea for universal adoption. Actually, it is more complex than the slight modification I have used here. But it assigns a letter designator to the basic booster with dash numbers to indicate modifications created by adding upper stages. This system is presented in Table 1, which also includes the important factors associated with each vehicle. I've made an attempt to include some of the historical vehicles in order to provide a bit of perspective.

The basic U.S.S.R. launch vehicle was their first-generation ICBM sometimes referred to in the West —but not in the U.S.S.R.—as the "T-3" and powered by four RD-107 and one RD-108 rocket engines. This is the Type A Launch Vehicle, or simply the ALV. It was used to boost the first three sputniks into orbit.

With the addition of a top stage, the Soviets created the Type A-1 Launch Vehicle, or A-1LV. This was used as the workhorse of the U.S.S.R. space program for a long time and was highly reliable . . . so reliable, in fact, that it became the first man-rated booster. Its orbital capability was a nominal 10,-500 pounds and was used to launch the Vostok manned spacecraft. It was also used to send the first three Luna spacecraft to the Moon.

With either an additional stage, or an improved and up-rated second stage, the basic workhorse booster designed and developed by the Korolev team became the A-2LV that was available about 1960 and man-rated for the Voskhod flights by late 1964. It has a nominal capability of about 15,000 pounds into "standard orbit" (100 n.m. circular earth orbit). It will also boost some 2,200 pounds to escape and was probably used for the Venera shots.

The A-2LV was so reliable that it was used as the booster for the Soyuz spacecraft following re-direction of that program after the disaster of Soyuz-1. This booster is either the standard A-2LV or a modified A-2LV with different upper stages . . . but it has been used to launch the Soyuz spacecraft and their unmanned Kosmos precursors. More about that later.

Using the original ALV to launch the 184-pound Sputnik 1 was like using a sledgehammer to swat a fly, and the same held true later when the Soviets needed launch

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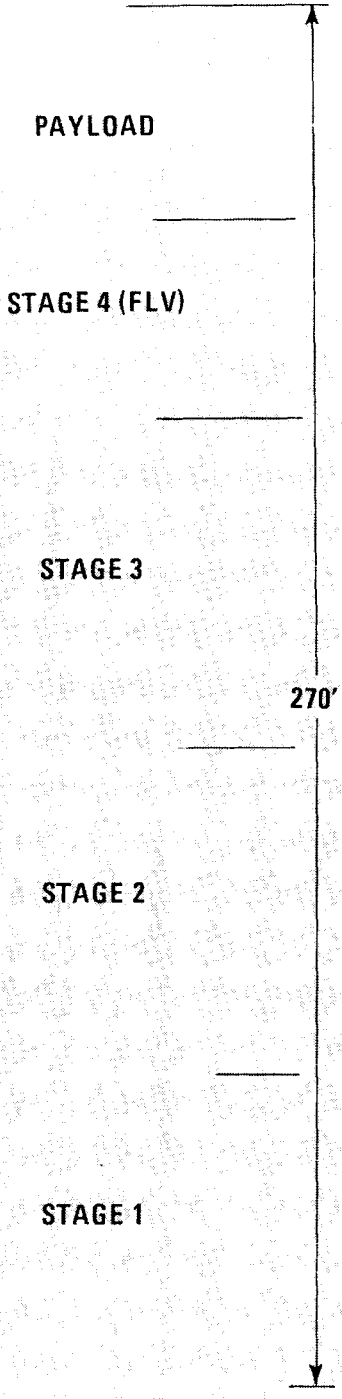

FIGURE 3.
SPECULATIVE USSR
"G" LAUNCH VEHICLE

Payload:
450,000 lb. to Orbit
145,000 lb. to Escape

STAGE 4 (FLV)

Thrust: 600,000 lb.
Gross Weight: 327,000 lb.

STAGE 3 (3 Modules)

Thrust: 2,500,000 lb.
Gross Weight: 1,523,000 lb.

STAGE 2 (7 Modules)

Thrust: 6,160,000 lb.
Gross Weight: 3,550,000 lb.

STAGE 1 (19 Modules)

Thrust: 17,000,000 lb.
Gross Weight: 9,614,000 lb.

Base Diameter: 75 ft.
Lift-off Weight: 15,159,000 lb.

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vehicles to boost the smaller satellites of the Kosmos series. (Kosmos is a general "cover" name that the U.S.S.R. has hung on surveillance satellites, FOBS tests, unmanned spacecraft tests, metsats, comsats, and anything else they don't wish to reveal at the time.) In addition, the A-1LV and the A-2LV are very large, very expensive, and very much needed for manned and interplanetary missions. So the Soviets developed some smaller orbital launch vehicles by adapting military missiles, just as we did in the U.S.A. By adding an upper stage powered by the RD-119 rocket engine, the Soviets were able to use two of their missiles as space boosters.[4] The smaller of these, the BLV, uses the RD-119 top stage on a SANDAL IRBM (SANDAL is the NATO code name for this ballistic missile). The BLV is roughly comparable to the U.S.A.'s Thor Agena D and will place roughly 1,200 pounds into standard orbit and boost some 200 pounds to escape.

To create a somewhat larger intermediate satellite launch vehicle, the Soviets added the RD-119 upper stage atop their SKEAN MRBM to give them a vehicle comparable to the U.S.A.'s Atlas Agena D or Centaur. This CLV has been used to orbit the Molinya comsat, the Nimbus-class Meteor metsat, probably the Elektrons, and other heavy spacecraft. The CLV would have an orbital capability of about 7,500 pounds and an escape capability of possibly 800 pounds.

On July 16, 1965, the Soviets lobbed into orbit the Proton 1 cosmic laboratory weighing nearly 27,000 pounds, followed by another Proton in November of 1965 and Proton 3 in July of 1966. But they were "little" Protons compared to Proton 4 launched November 16, 1968 with a weight of 37,485 pounds . . . not counting the weight of the final rocket stage, according to Tass. According to Soviet sources, the Proton launch vehicle is not an up-rated ALV-type, nor was it developed by the Korolev team. Various sources in the West, working from very scanty Soviet data, have estimated the Proton launch vehicle to be in the 3-million-pound-thrust class.[3,4]

But the big Proton launch vehicle isn't the biggest in the Soviet stable. On May 1, 1967, the Soviets disclosed that Soyuz-1 was launched with a booster having five times the thrust of the A-1LV.[9] This means a new and more powerful launch vehicle in the 6-million-pound-thrust class.

What do these new vehicles look like? How big are they? What are their capabilities?

Any person with a slide rule, a pad of paper, a pencil, and any one of the numerous handy-dandy handbooks of astronautical engineering can make a good guess, given a little time and skull sweat.

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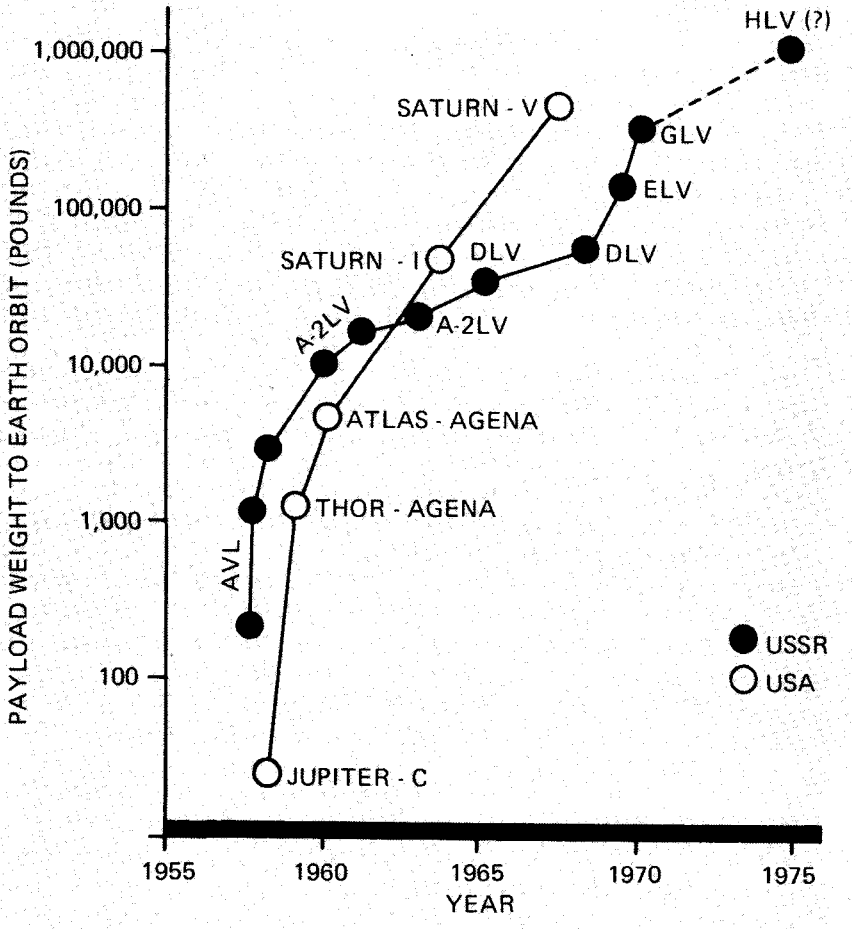
PAYLOAD TO ORBIT TREND

Figure 4: Comparing payload-to-orbit trends, we can see that the USA equalled and surpassed the USSR once military vehicles and Saturn became operational. The projected Soviet HLV with million-pounds-to-orbit capability is right on the general trend curve for 1975.



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But there is really one more key that seems to unlock some very interesting possibilities regarding *modular* construction of the big Soviet boosters.

Again, Major General Nikolai Kamanin, this time being interviewed by The Workers' Agency Correspondent R. Badowski as reported by the Warsaw PAP International Service in English on March 10, 1967:[10] "Within three years, team flights to the silver globe will be frequent, and rockets will be flying to the Moon along a beaten track. Whether this will be *from a parking orbit, or straight* from the Earth, is hard to say now. We will need a rocket capable of carrying a load of 60 to 70 tons into the cosmos . . ."

These are 2,205-pound metric tons. Armed with this additional information, our engineering tools, and a couple of assumptions, it is possible to create a stable of advanced, modular space vehicles—the DLV or Proton launcher, the ELV or Soyuz launcher, and the GLV or lunar logistics vehicle.

These vehicles are indicated in Table 1 and the engineering results are shown in Figures 1, 2 and 3.

They are also based on the following assumptions:

1. Specific impulse of 310 seconds.

2. Propellant mass fraction for each stage or module of 0.91.

3. Use of a final stage with 600,000 pounds of thrust and a 14.8-foot diameter—which is incidentally the shroud diameter of the Proton satellites *and* the base of the Soyuz!

4. Soviet development of a "megapound module," based on the SS-9 paraded in Red Square, using an 800,000-pound thrust cluster of 7 thrust chambers and tapered tankage.

If we put these together as shown in Figure 1, we have the speculative DLV perfectly capable of orbiting 25,000 to 45,000 pounds. It uses the final stage noted above—tagged the FLV because all by itself it has a formidable low earth orbit capability and may be the FOBS vehicle—plus an initial stage of a cluster of 3 "megapound modules," providing a lift-off thrust of 2,500,000 pounds and a lift-off weight of 1,880,000 pounds. This speculative DLV closely matches what the Soviets have revealed to date, give or take a little bit here and there for assumptions, round-off of figures, and general shoe-horning on my part.

To get the ELV the Soviets have admitted using to launch Soyuz-1,[9] we simply take the DLV and add a lower stage consisting of a cluster of 7 modules. Geometrically, this makes a great deal of sense because, if you will play around a little bit with a bow compass you will discover that three circles cluster nicely—as in the 3-cluster—and that the next convenient geometric cluster is 7. The resulting ELV

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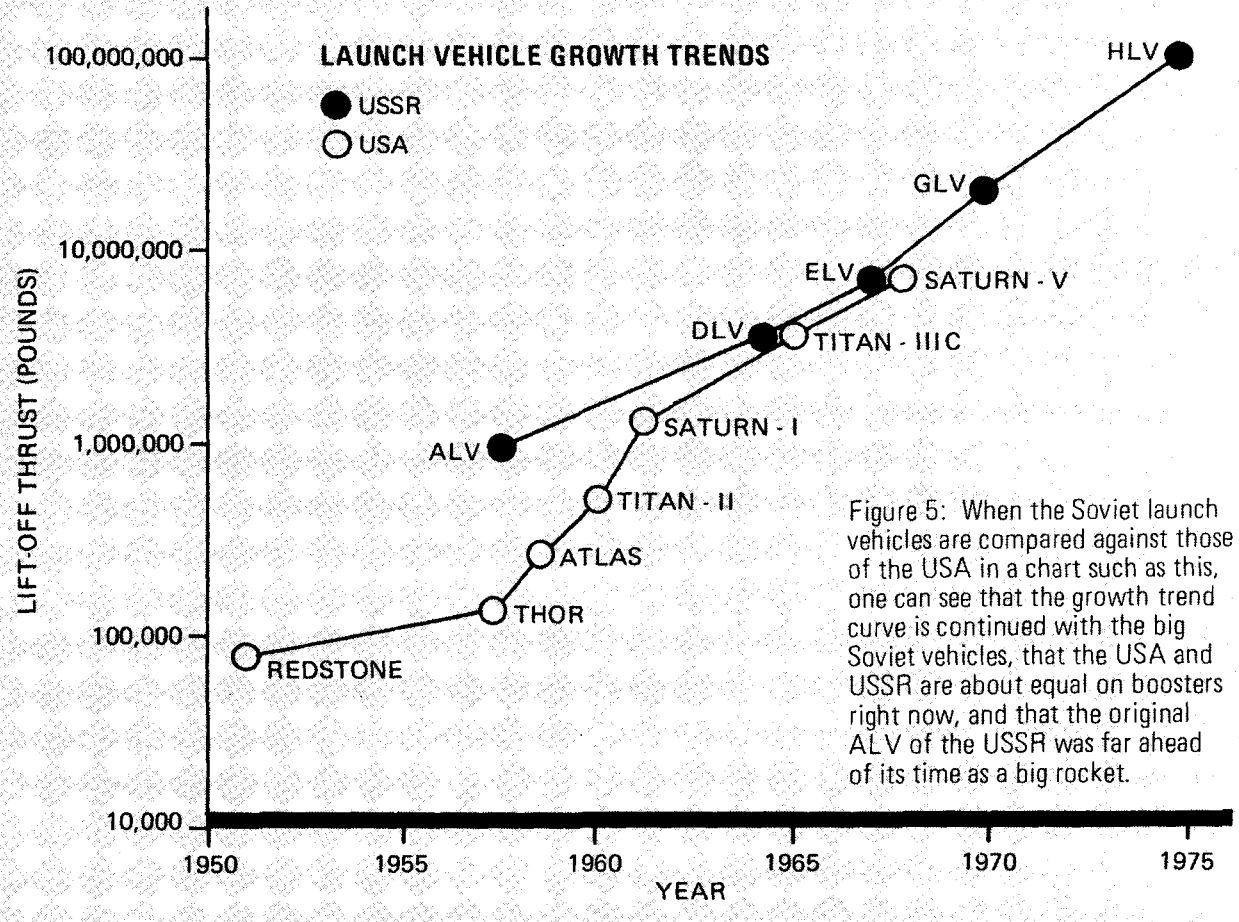

Figure 5: When the Soviet launch vehicles are compared against those of the USA in a chart such as this, one can see that the growth trend curve is continued with the big Soviet vehicles, that the USA and USSR are about equal on boosters right now, and that the original ALV of the USSR was far ahead of its time as a big rocket.

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stands roughly 208 feet high with a base diameter of 55 feet. Its lift-off thrust is 6,160,000 pounds pushing a lift-off weight of 5,545,000 pounds and having an orbital capability of 145,000 pounds, roughly 60 tons. This is a little bit smaller than Saturn V with about half the orbital capability because the assumptions included standard chemical propellants with no high-energy upper stages.

To come up with the Kamanin 60-ton-to-escape ship usable as a lunar logistics vehicle, we simply add a lower stage to the ELV. The resulting GLV is a four-staged vehicle standing perhaps 270-300 feet high. The lower stage is a cluster of 19 modules—you can easily wrap 11 modules in a circle around a cluster of 7 modules—with a base diameter of 75 feet. Its lift-off weight is 15,159,000 pounds with a lift-off thrust of roughly 17,000,000 pounds. It would have an orbital capability of 450,000 pounds or be able to thrust 145,000 pounds to escape.

The GLV may fly in 1969. Soviet space watchers have been looking for it. It is the Soviet "Saturn V" that former NASA Administrator James Webb alluded to[11] . . . which is why it is sometimes referred to as "Webb's Giant."

This fills out the currently-expected Soviet launch vehicle stable except for one rather "iffy" possibility. General Kamanin in his 1967 Warsaw interview[10] alluded to a larger vehicle possibility: "If the present rate of development of rocket technology is maintained during the next ten years, then vehicles of 100 to 200 tons will appear to carry crews towards Mars and Venus." And Soviet professor G. Petrovich stated in a November 1965 interview[12] that vehicles weighing 400 to 500 tons would be orbited by the end of the 1970s.

This is a monster, tentatively tagged as the HLV, a manned planetary vehicle capable of putting Soviet cosmonauts on Mars by 1980 in accordance with Kamanin's schedule. Taking Soviet development times into account so that the HLV could be man-rated by 1979, we might expect to see something like it fly on an unmanned mission about 1975. The HLV might be able to loft the fabled "million pounds to orbit," plus some extra . . . or to take a half-million pounds to escape.

The Soviet ELV is smaller than our Saturn V, and in reality the GLV and HLV are not beyond the realm of possibility. Table 3 indicates the level of launch vehicle planning in the U.S.A. as of 1961.[13] The U.S.A.F. solid Novas represented a separate line of development from the NASA liquid Novas. The Golovin Committee put the U.S.A. on the path of Titan-III as a standard U.S.A.F. intermediate launch vehicle, comparable to the U.S.A.F. Segmented on the chart;

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the Saturn-Ib as an *interim* launch vehicle to check out the cluster concept and the Apollo CSM in earth orbit; and the Saturn V as the U.S.A. large launch vehicle, which is comparable to the NASA Nova-1 on the chart. If we had built U.S.A.F. Nova-3, it would have been comparable to the Soviet GLV . . . and it was planned in 1961 to have that 25,000,000-pound-thrust monster flying by 1968. As for something American to compare the U.S.S.R. HLV again, consider the U.S.A.F. Nova-4 and U.S.A.F. Nova-5 concepts of 1961 . . . and note the planned operational dates!

Three questions immediately come to mind upon looking at this speculative Soviet launch vehicle list.

TABLE 1

NATION: U.S.S.R. SPACE LAUNCH VEHICLES DATE COMPILED: MARCH 1969

NAME OR DESIGNATION	DESCRIPTION & REMARKS	100 N.M. PAYLOAD	ESCAPE PAYLOAD	CURRENT STATUS	OPERATIONAL DATE	MAN-RATED DATE
ALV	ICBM. Sputnik 1, 2, & 3	3,000	N.A.	Obsolete	Oct. 1957	N.A.
A-1LV	Luna 1, 2 & 3 VOSTOK launch vehicle	10,500	960	Obsolete	1959	Apr. 1961
A-2LV	Venera. VOSKHODS. SOYUZ 2, 3, 4, & 5	15,000	2,200	Operational	1960	Oct. 1964
BLV	SANDAL IRBM + top stage Small KOSMOS launcher	1,200	200	Operational	1962	N.A.
CLV	SKEAN MRBM + top stage Large KOSMOS launcher Molniya, Elektron, etc.	7,500	800	Operational	1964	N.A.
DLV	PROTON launcher	25,000 to 45,000	3,000 to 4,000	Operational	1965	N.A.
ELV	SOYUZ 1. Earth-orbit shuttle launcher	145,000	45,000	Development	1966	1967 (abortive)
FLV	FOBS launcher (SS-9?)	4,000	N.A.	Operational	1966	N.A.
GLV	Lunar logistics vehicle "Webb's Giant."	450,000	145,000	Development	1969(?)	1972(?)
HLV	Manned planetary and lunar cargo vehicle	1,300,000	500,000	Design	1975(?)	1979(?)

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1. Why didn't the Soviets man-rate the DLV, or do they intend to do so in the future?

2. Why was Soyuz-1 launched on the ELV while Soyuz-2 through Soyuz-5 were launched in a modified A-2LV?

3. Why is the GLV needed?

Again, we can look inward to the U.S.A. for some clues, or at least for a rationale.

The DLV may be an interim vehicle like the Saturn-Ib. The DLV may be simply a test configuration or it may be used strictly as an unmanned earth-to-orbit logistics vehicle. After all, the Soviets do not have to man a logistics vehicle because they have already proved a capability for unmanned rendezvous and docking. This saves pilots and saves money because you

TABLE 2

NATION: U.S.A. (Actual) SPACE LAUNCH VEHICLES DATE COMPILED: March 1969

NAME OR DESIGNATION	DESCRIPTION & REMARKS	100 N.M. PAYLOAD	ESCAPE PAYLOAD	CURRENT STATUS	OPERATIONAL DATE	MAN-RATED DATE
Scout	All solid minimum vehicle	250	30	Operational	July 1960	N.A.
Delta	Thor-based vehicle	930	100	Operational	May 1960	N.A.
Thor-Agena D	Thor-based vehicle	1,570	N.A.	Operational	June 1962	N.A.
TAT-Agena D	Thor-based vehicle + 3 solid strap-ons	2,200	N.A.	Operational	Feb. 1963	N.A.
Atlas D	ICBM vehicle	3,000	N.A.	Obsolete	Late 1958	Feb. 1962
Atlas Agena D	ICBM-based vehicle	6,300	950	Operational	July 1963	N.A.
Centaur	ICBM-based vehicle + hi-energy top stage	9,700	2,300	Operational	1962	N.A.
Titan II	ICBM-based vehicle	7,500	N.A.	Obsolete	Mar. 1962	Mar. 1965
Saturn I		22,500	N.A.	Obsolete	Oct. 1961	N.A.
Saturn Ib	Apollo interim vehicle	35,000	N.A.	In storage	Feb. 1966	Oct. 1968
Titan IIIC	ICBM + top stage + 2 solid strap-ons. MOL.	25,000	5,400	Operational	June 1965	1970
Saturn V	Lunar launch vehicle	250,000	95,000	Operational	Nov. 1967	Dec. 1968

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don't have to man-rate your logistics vehicle!

Soyuz-1 was a disaster to the Soviets akin to our Apollo-5 fire. It caused them to re-trench and regroup their effort. Soyuz-1 was big and heavy, perhaps as much as 50,000 pounds, and the Soviets admitted it was designed for a range of flight durations from an eight-day lunar mission to space station durations[9] of thirty days . . . perhaps more. When Soyuz-2 through Soyuz-5 were flown, Soviet TV pictures and later Sovfoto releases showed the Soyuz spacecraft perched atop the A-2LV.[14] One can certainly see that the Soyuz and the A-2LV just aren't made for each other. It is strictly speculation on my part that the Soviets stripped Soyuz to a two-day orbital

TABLE 3

NATION: U.S.A. (1961 proposed) SPACE LAUNCH VEHICLES DATE COMPILED: March 6, 1969

NAME OR DESIGNATION	DESCRIPTION & REMARKS	100 N.M. PAYLOAD	ESCAPE PAYLOAD	PLANNED OP. DATE	CURRENT STATUS	OPERATIONAL DATE	MAN-RATED DATE
Titan II/ Centaur	2-staged. 600,000-lb. thrust.	15,000	5,000	1963			
USAF Phoenix	3-staged. Solid booster. 1,250,000-lb thrust	35,000	15,000	1963			
USAF Segmented	3-staged, Solid boost. 2,500,000-lb. thrust	60,000	25,000	1964			
USAF Nova	Solid booster. 3-stage. 6,000,000-lb. thrust.	100,000	40,000	1965			
USAF Nova-1	Solid boost. 4-stage. 12,000,000-lb. thrust.	300,000	150,000	1966			
USAF Nova-2	Solid boost. 5-stage. 17,500,000-lb. thrust.	350,000	170,000	1967			
USAF Nova-3	Solid boost. 6-stage. 25,000,000-lb.-thrust.	500,000	250,000	1968			
NASA Nova-1	Liquid. 4-stage. 9,000,000 lb. thrust.	240,000	70,000	1969			
NASA Nova-2	Liquid. 6-stage. 12,000,000-lb. thrust.	380,000	120,000	1970			
USAF Nova-4	Solid boost. 6-stage. 35,000,000-lb. thrust.	1,000,000	500,000	1969			
USAF Nova-5	Solid boost. 7-stage. 50,000,000-lb. thrust.	2,000,000	1,200,000	1970			

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spacecraft, lightening it considerably, and put it atop their most reliable man-rated booster so that they could eliminate having to tangle with two new systems at once —the ELV and the Soyuz. When the basic, stripped Soyuz is proved —and it may be, now—we will probably see it atop the ELV in its original heavy configuration as the universal manned spacecraft for both the Soviet earth-orbit goal and the lunar goal.

But why the big GLV? Isn't it possible to use earth orbit rendezvous (EOR) to achieve the same results? The Soviets have never claimed that they were going to use EOR to get to the Moon. I specifically asked Dr Sheldon about this one. However, the Soviets have shown a preference for either direct flight from the earth's surface to the Moon or direct flight using a parking orbit. (An earth parking orbit allows you to open up your launch window so that you aren't up-tight on launch time.)

It is cheaper to build the GLV than it is to use EOR with ELV's. Look at it this way:

The cost of the vehicle can be reckoned not in rubles or equivalent dollars, but simply in the number of modules expended in each case.

A DLV uses 4 modules (including FLV stage)

An ELV uses 11 modules (including FLV stage)

A GLV uses 30 modules (including FLV stage)

To place 145,000 pounds of payload into translunar trajectory, the following number of launches would be required with each vehicle, assuming EOR for the DLV and ELV and direct flight with the GLV:

DLV: 18 launches. 72 modules used.

ELV: 4 launches. 44 modules used.

GLV: 1 launch. 30 modules used.

So it is cheaper in terms of propellants and materials to go direct with the GLV. Also, if the Soviets get their lunar outpost, base, or proto-colony going in the early 1970s—say about 1972-1973—it will take much less manpower and be more timely to launch direct with the GLV full of logistical material.

But economics may not be the decisive factor in the Soviet space program to the extent it is in the U.S.A. program. The Soviet economic system is quite different—very few Americans really know *how* different—and the Soviet Union has its religious-emotional involvement with cosmonautics to the extent that it may contribute heavily to what Leon Herman of the U.S. Library of Congress called "the short blanket economy of the Soviet Union—the feet get cold when the shoulders receive aid."

And the Vice President of the

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U.S.S.R. Academy of Sciences, B. P. Konstantinov, said in February 1968,[15] "Space research is not so expensive as it is useful. Not only because it promotes science and develops technology, but it also has great economic importance—it makes possible increasingly precise weather forecasts, it facilitates air and sea navigation, it makes topographic registration and geological research simpler . . . and its importance for defense is enormous. It is kown that there are opinions according to which the abandoning of the space programs would make mankind happier. I do not think so. On the contrary, I am convinced that it is the other way around."

Have you heard anything similar from the U.S.A. National Academy of Sciences recently?

With this sort of backing and with the type of launch vehicles in hand that have been guesstimated herein, the Soviet Union stands a good chance of being the one who in the long haul, conquers the Solar System. ■

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POLITICAL SCIENCE—MARK II

In our issue of October 1967 we ran an excerpt from the opening of an important Chinese paper on nuclear physics, delivered at a Peking seminar; the thing of interest about it was that the first few pages were devoted entirely to praising the great, the glorious, the magnificent Thoughts of Mao, and how the Great Mao's thoughts, when applied to nuclear physics problems, led to . . .

The paper, I've been told by physicists capable of understanding that level of mathematics—Lord knows I'm not!—was a first-rate piece of work. Politics there certainly was—but the science was not by any means squeezed out. (The fact that China beat France to a successful hydrogen fusion bomb suggests that their nuclear physics is first-rate work.)

I have over the last few years brought up the subject of psi, and the facts of dowsing, and protested that science and scientists refused to apply the scientific method of open-minded experiment—and have been lectured by many kindly people on the subject of how little I understood. That that wasn't at all the way scientists were—that perhaps a few black sheep among them might not be objective and reasonable, but . . . well, after all Galileo was hundreds of years ago! Science doesn't suppress facts *now!*

I present herewith a magnificent example of Political Science, Mark II—and it's a worse mess, by far, than the Chinese piece. The Chinese science was honest, even if it did start with some boot-licking.

The National Academy of Sciences—the nation's official body of scientific authorities and advisers to government departments—by a vote of roughly two hundred to ten, refused to consider the idea of making scientific studies of genetic differences of intelligence among racial groups.

Dr. William Shockley, Nobel Medalist for his work in the discovery of the transistor, had proposed that such a study was needed.

Dr. Frederick Seitz, President of the Academy, explained that, "The strong feeling of the majority of members is that it is essentially impossible to do good research in this field as long as there are such

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great social inequities, and such research is also so easily misunderstood in these times."

In other words, the Academy, chartered by the government to give scientific advice, has decided that the facts concerning a certain subject—genetics and intelligence—are politically Untouchable, and that objective science should not be applied.

The fact that some data in that area of fog might—just *might!*—be helpful is not to be considered.

Of course, it's perfectly obvious that the scientists, who thus voted against applying science to an area of foggy unknowns, have strong convictions. They must be uniformly, personally convinced that such an investigation would prove a politically embarrassing fact—that genetics *does* make a difference.

They must, individually, personally, be so deeply convinced of that that they're *sure* the result would be embarrassing politically, and hence don't want anybody even looking to find out.

Since this decision was reached by the National Academy of Sciences, in professional meeting assembled, it represents the attitude of Science in America—and there can be no argument that those men weren't scientists, or that they're just a few individual scientists.

The attitude of Science in America is: Questions which might have embarrassing answers should *not* be investigated. Political pressures are more important than truths in science. We will have nothing to do with any effort to clarify a murky issue which might turn out contrary to our convictions—or might turn out according to our convictions, which we didn't want publicly exposed.

In professional meeting assembled, the National Academy of Sciences has voted to confirm Pope Urban's basic proposition: That investigation of questions that might shake the faith must be suppressed.

O.K. readers—anyone still doubt my statement that Science and Scientists refuse to investigate psi phenomena that can be demonstrated, and are in common engineering use "because scientists don't act that way?" ■ The Editor

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damper

There's nothing like adequate liquid assets ready for use when a nation faces military invasion.

E. G. von WALD

Illustrated by Peter Skirka

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The reception room was empty except for me and the cuddly-looking sec who spent most of her time at her desk. There wasn't anything I could do but wait, so I waited. The only thing they had there to read was a current issue of *Weather Control Technologist,* which I had already seen.

Now and then, the girl would pause and glance up at me in a speculative sort of way, then quickly get back to her work again. After about two hours, a man came in, handed her a form which she examined carefully, then they both stared at me for a moment. Eventually the man went out again.

If a genuine role hadn't been so hard to find, I wouldn't have wasted my time there. But I was kind of a serious nut for a young fellow. I could have continued in school for a number of years yet—I still had plenty of my statutory Student Assistance entitlement left. It was just that I decided to do something different for a change, maybe something useful. You know how kids are.

My patience began to wear thin, and I finally got up and went over to the sec. I wanted to know what the delay was, but I was determined to be very polite about it. I wanted that role.

"Hey, Doll-baby," I said, "what's with it, huh? Is the deal for real, or should I hop on back to the pad and forget it?"

"I'm sorry, Dr. Parker," she said softly. "You'll have to speak to Mr. Hagen. He's the chief."

"That's what I came here for, Doll," I replied. "But it's getting to be a little draggy. By the way, how about a little tip on this chief-man —the Hagen guy. Is he really the fusty formal they say he is? I mean, the word is out that Hagen Hates."

She hesitated, and I could sense that she disapproved of my collegiate chatter. "I suppose," she finally said, "you would call him cubic."

I thought about this a moment. The good rule has a nice way of phrasing it. When in squaresville, be rectilinear.

"In that case, Doll," I told her earnestly, "I'm an n-dimensional quartic. I mean, I'm here after a role. Hell, I'll even call it a job if it does any good."

She didn't get a chance right then to comment on my using the old-fashioned word for it, because her desk-com burped and a raspy voice said, "Alice, I have about ten minutes left. Is there anybody I have to see?"

"Yes, Mr. Hagen," she answered. "Dr. Joshiah L. Parker is waiting for his interview. He filed an application for service operative."

"Probably a waste of time," the raspy voice snarled. "Has Security checked him yet?"

Alice's eyes flicked up to me with faint amusement. "The preliminary check was made while he waited, sir," she said, "and the conclusion was favorable. I just got the report

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ten minutes ago." Before raspy-voice could give away any more house secrets, she added, "Dr. Parker is standing right beside me at the moment."

There was a pause. Then, "Oh." Another pause. "All right, send him in."

When the desk-com shut up, I said anxiously, "Hey Doll, what's with this Security bit? This agency isn't supposed to have any sensitive roles."

"I thought you were going to call it a job."

"O.K., job then. But what about the Security business?"

"I'm sorry, you'll have to speak to Mr. Hagen about that."

"I've got my pride, you know."

"I understand."

"You know what everybody thinks about people who do classified work these days."

"Do you want to see Mr. Hagen, or don't you?"

I decided I would look into things a little further. Call them what you like, jobs or roles, they were still hard to come by at the time.

Unsmilingly, she led me to the big, forbidding door marked, "H. C. Hagen, Chief, Federal Weather Control Service."

Hagen turned out to be a small man with lots of genuine gray hair and a somewhat harried expression on his face. Alice explained that I was disturbed by the Security routine.

"Sit down," he ordered sharply.

I obeyed. Alice slipped my application crystal into the appropriate slot on his desk, set the Security report on top, and departed.

Hagen spent a minute or so looking at the report. Finally he grunted:

"All right. As far as these Security checks are concerned, we don't advertise it, but it's within our authority to clear our own personnel. The Federal Weather Control Service is an independent agency of the U. S. Government. You understand that we are not connected in any way with State or Defense. Got it?"

I nodded. Everybody knew about State and DOD. Usually, it wasn't considered the best of taste to discuss them, but Hagen didn't seem to mind.

"We have to have our own Security," he said with surprising heat. "Those two bumbling departments are so big and self-perpetuating that it's been decades since anybody has been able to handle them—even Congress, to say nothing of the President. And I'm not going to let them get their fiddle-faddling fingers into our operations.

"But," he added in a more moderate tone of voice, "you seem to be clean."

"Oh, I don't have anything to do with them," I hastened to assure him.

"You better not," Hagen muttered. "We'll make a more extensive check later, just to be sure."

He pushed a switch on his desk

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with his big thumb, and the datascope lighted up.

"Now let's get to business." He looked at the scope. "I see you have a PhD in Meteorology. Uh huh. Also two semesters of advanced study in the field. Well, as I guess you understand, that's a pretty ordinary educational background these days. Can you do anything useful —like run a TT machine?"

Score one for me. "Yes, sir," I said. "I took a summer course in it last year."

"Interesting. Most of your colleagues that I have interviewed lately consider running a manual machine as beneath their dignity."

I listened with every appearance of humility I could muster. There didn't seem to be any point in telling him that, owing to a quirk of scheduling, TT Operation had been the only course I could take at the time that would keep my fat Student Assistance payments coming in.

Hagen was saying, "What we are doing at the moment is simply expanding our personnel to handle our recently-expanded equipment potential. The Weather Control Satellite net is finally complete. It's world wide, now, counting the part that Russia put up. Our interest at the moment, of course, is the domestic utilization of this potential. In the past, our control of the probability density was incomplete. Now it should be very good, at least over those parts of the country that are amenable to our techniques.

"Programs have already been worked out for handling the work. What we need right now is not chicken-track artists but people who can think a little bit and make decisions. Of course, technical competence is still basic."

After a final glance at my application, he switched off the datascope and leaned back in his chair. He studied me for a few moments with sleepy eyes, then asked, "What's the cycle for the Arizona desert?"

I repeated the words, "Arizona Cycle," and it served nicely as a mnemonic device. My thinker switched in the ag-tape.

"Arizona flatlands. Crop is a three-gene hybrid dwarf wheat. Low moisture retentivity soil. Six centimeters of precipitation per day for a three-week fallow period. Low cloud cover with no rain for a week's planting time, then three centimeters per day with moderate sun for germination. Strong sun and dry alternating with cloud and four centimeter days for six weeks. Sun and dry for two weeks harvesting, then switch back into the fallow period again for fertilizing and redistribution of substrates."

That was strictly off the margin of one of the seminars on "ecological and other purposes."

Hagen listened without visible reaction. He nodded and asked for South Dakota. I gave him South Dakota.

"All right," Hagen said sleepily.

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"How about Washington, D. C."

Without the slightest hesitation, I swung into the eastern Maryland-Virginia cycle. "It's mostly urban area, except for a small tobacco-growing region, and they are both pretty tolerant of conditions. Just keep things fairly moist, plenty of sun and above all make sure the low-level circulation stays active. Otherwise it's all smog."

This was right out of the book, but as I was finishing up I could see that it must be the wrong book. Hagen was easy to read on that.

He said, "All right, Parker, that's nice and simple. Sun in the day and occasional rains at night, late, when everybody's asleep. So you've just dialed two centimeters of precipitation for one hour duration early Wednesday morning. Three minutes after it starts, you get a frantic call from State. The Kenyan Embassy is giving an unscheduled late garden party for the wives of the Theatrical and Fan Society. Now what do you do?"

I swallowed. Aborting a program hadn't been given much attention at the University. It suggested "emergency" and weather emergencies were supposed to be obsolete under the new technology.

"I'm waiting, Dr. Parker," Hagen said irritably. "You've turned the spigot on at the wrong time. Let's see how you get it turned off."

The thing he wanted was simply the code number of a standard abort sequence. Since I couldn't think of any offhand, I thought I would try to fog it, like we do on campus.

"You can't do it just like that," I said. "About the only quick way of stopping the weather in one locality is to dump it all on some nearby locality. This would probably overload things there, and those people have their rights, too."

"Not around Washington, D.C.," Hagen snapped. "Not with all those postage stamp-sized countries that constitute embassy city. Each of them has the legal right to stipulate the weather density over their sovereign territory there, and don't think they don't invoke it."

I made another attempt to save face. "If you try to divert it to any great distance in a hurry, there is serious danger of causing a tornado. Nobody can control a tornado once it forms."

"Precisely," said Hagen. "Which means you have to be ready for anything, with no room for mistakes."

He paused, waiting attentively. Since I wasn't fooling him with the fog, I cut it out. "I'm sorry, Mr. Hagen, but I can't answer your question at the moment. I would have to look it up."

"Yes," Hagen muttered. "So I noticed. I also noticed that you wasted several minutes of my time trying to talk your way out of it."

He pulled a small tab from a drawer, marked it up, and laid it on top of his desk.

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"The Weather Service is a small agency. The President has great plans for it, and he likes it small. So do I. We don't want a lot of personnel just to have a lot of personnel. We know we are important without that."

His eyes took on a peculiar glint as he continued.

"State Department has lots of personnel, but somehow they can't manage to prevent the small brush-fire wars that keep breaking out here and there with this country in the middle. Yet in today's world, that is their most important job. Defense Department has lots of personnel, but for one reason or another they find it impossible to fight those brush-fire wars effectively, and that's *their* job.

"The Weather Service isn't going to fall into the personnel trap. One of my objectives is to keep the number of people small but the quality high. That's the only way the agency can be kept under control. Since Congress had the singular wisdom to make us independent of those two departments—no matter how much they howled about it—it is possible to accomplish this."

The tab slid easily across the desk to me.

"That is a temporary appointment. You will get two months of special study. If you don't wash out there, you graduate into indefinite status for one to three years—the exact length of time will depend to some extent on your performance. If you manage to survive that probationary period without fouling up your station, we will take full responsibility for you in the future and give you permanent status.

"Meanwhile, you know what we expect of our operatives. Keep clearly in mind that I personally review each operative's record. And I don't tolerate bunglers."

My hand shook a little as I picked up the tab. I couldn't help it. I had figured that after the Washington dub, I had already flunked.

Hagen saw it, and he suddenly grinned.

"Cool it," he said. "I've got a hunch you'll make out."

It was good of him to say that, but when I saw the study schedule, I wasn't so sure. The first part of it was law—civil law. After all the years I had spent in school, the idea of actually becoming subject to civil law was something of a shock. Student councils do the legislation for the campus, and they don't have much use for Blackstone. It's strictly the freedom party straight down the line. I guess that's why Hagen insisted on the course on civil law.

After that, they got into the politico-economics of the history of weather control, and the international problems of getting the satellite net up in cooperation with Russia. Quite a bit of attention was given to the reasons why much of the world still didn't have any way of getting connected into the net.

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One big reason was that a lot of the benefits were pretty automatic. Like, for instance, most of the really big storms that do the most damage are spawned either at sea or in the polar regions. The U. S. and Russia clean up on them as a matter of necessity, and everybody else gets the advantage automatically.

As far as precipitation-radiation management was concerned, it was a different thing. Broad, open plains were easy to handle, but mountains were out completely. Too many random currents, lateral as well as vertical, made control there impractical. River valleys were considered very tricky.

When you add to this the fact that the probability density for weather could only be affected for a couple of hundred kilometers from a control station, you get the idea. Most countries have a pretty complex terrain situation, which requires a lot of stations to effect reasonably good control. And all this takes m-o-n-e-y.

It just wasn't very economical as a business proposition for most little countries to invest in the necessary equipment.

The study load was pretty heavy, but I was used to that. Once I got into the swing of it, I had a little extra time on my hands. I got the idea I might be able to fix it with Alice, the chief's sec. Like I said, she's got plenty of it, and that's what I liked.

Unfortunately, I mentioned my plan to my super, and he turned thumbs down right away. The man was literally shocked at the idea. In the Weather Service, he told me, working girls like Alice were considered a cut above the likes of people who didn't even have permanent status. How's that for democracy for you?

Anyway, the training was soon over, and I found myself farmed out to the Southern Indiana District. Since I didn't have any authority to make any decisions, about all I could do was to transmit patterns to the net on the TT.

I wanted permanent status pretty badly, so I watched my language, worked like a beaver, and took extension courses from the departmental educational section. I stayed up half the night, studying, so I managed to stay out of trouble. After about a year, they shipped me back to Washington for a special assignment.

Alice was as nice as ever, and I was pleased to find that she now called me by my first name.

"The chief says you are doing fine, Josh," she greeted me. "Real fine."

"That's good news," I replied. "Am I doing well enough to rate an evening of your company?"

"Oh, Josh," she laughed, "I wish it could be arranged. The trouble is, I have a hunch you are going to be either too busy or gone."

That didn't sound so good, but

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before I had time to meditate on it, Hagen called me into his office and told me that I was on loan to the State Department.

"State Department!" I echoed in amazement. "How come we're getting mixed up with that bunch?"

"Can't be helped," he said. "Call it what you like, State still pulls a lot of weight around this town. They've been trying to borrow personnel for some time now. I couldn't put them off any longer. Besides, their project strikes me as interesting this time."

"But why me?" I complained.

"You know enough to handle this. It's quite routine. All you have to do is to follow the instructions of your State man. He will have all the authority."

Riffling through some tapes, he found the one he wanted and stuck it in the datascope.

"Here we are. It's just an ordinary technological-assistance affair. Middle East. We get to backcharge State for the equipment, so it doesn't even hurt our budget. The only thing you have to worry about is to be careful. If I have to decide that you have impaired our peaceful reputation, you can guess what will happen to you the minute you get back."

He shut the datascope off.

"Oh, and incidentally," he added with a certain studied casualness, "keep in mind that where you are going there are always half a dozen independent nations within spitting distance. Since they are all perpetually on the verge of war with each other, be sure you keep your head down. I don't want any of my operatives getting shot."

I was still a little burned up about the assignment. I risked a little sarcasm and said, "Even junior assistant temporary operatives?"

"Uh huh," said Hagen, nodding. "Even junior assistant temporary operatives."

That was about all I got from the chief. However, I did manage to get that evening with Alice, after all, which almost made me feel good about the situation—for a while.

State Department, as you are no doubt aware, has a sort of peculiar reputation. The special envoy I was assigned to, happily, was a pretty fair sort of a guy. His name was Smyth, and as long as you could remember the "y," he was your buddy.

"This is a very important project," he told me earnestly. "International relations. Balance of power in the area and all that, you know. Keep the little brush-fire wars from breaking out. And, naturally, keep everybody friendly to our side."

"So what do you need a weather operative for?" I asked.

"That's just it," he said, positively glowing with enthusiasm. "There haven't been any stations estab-

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lished in this region yet. This is where we get the jump on the Kremlin. They promised one to the Burami State, but they haven't delivered yet."

"Burami State," I repeated carefully. "So that's where I'm going. That's one of those new little countries down there, isn't it?"

"It's fairly new, all right," said Smyth. "But that's not where you're going. Your assignment is to the Revised Sharja Enclave, right next door to Burami. Do you follow me?"

"I'm trying," I said.

"Well, the whole thing in a nutshell is that the people in this region have been largely dependent on imported foodstuffs for some time. Most of them don't seem to mind, but we are going to demonstrate in Sharja how they can become completely self-sufficient in this respect. With weather control, you can fix it so they can grow their foodstuffs right in their own soil."

"You are talking now about desert farming," I murmured thoughtfully.

"That's right. All they need is some rain."

"What about fertilizer? Desert sand doesn't hold nutrients any better than it holds water. They leach out in no time."

Smyth frowned. "Now that's interesting," he said and waited.

"Chichorganite is what they usually use these days."

"Precisely," he said immediately. "We'll get some of it and ship it right along. Just make up an estimate of how much will be needed." He smiled cheerfully.

"Machinery," I said.

"Machinery?" The smile was turned off.

"Desert farming isn't like a vegetable patch. It has to be handled like an assembly line, or it is a waste of time to try it."

Smyth considered this a moment, then cleared his throat. The smile came back. "Well, Doctor," he said very smoothly, "I'm certainly glad to see you are on your toes. This is my own project, you know, and I was thinking along just about those lines myself. Sort of hoped you might help me make up the list of items."

He hesitated, then added cautiously, "Er, any special kind of seed required?"

"The usual hybrids," I told him. "I'll give you a list. Incidentally, are you going to design the weather cycle for the place or do you want me to?"

"Oh, I'm sure you can hold up your end, all right," Smyth said. "I don't believe in sticking my nose into another man's specialty. I'll give you the general picture when we get there, introduce you to the local folks, and you can sort of take it from there."

It sounded like a whole lot more authority than Hagen expected me

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to have, but I was all for it. I figured it might give me a chance to prove myself. So I worked up a list of essentials for Smyth to order right away, including the control equipment. I figured I could order the rest of the material in from the site, once I was sure what was going to happen. All this didn't take very long, and pretty soon I was on the zipper rocket en route to my destination. I had the forethought to pick up a tape on the local setup to study on the way.

What they called "Modern Sharja" was a tiny little country in the midst of tiny little countries. It was long and narrow, with mountains running the long way on one side, and flat lowlands opposite. The northern tip, which verged on the gulf, had a lot of oil fields that were beginning to show signs of depletion. Most of the population —what there was of population— lived toward the south, in the foothills between the mountains and lowlands.

I decided that the only suitable place for the project would be in the sandy lowlands to the south. The people lived around there, and they could watch the whole thing. The foothills themselves weren't useful, since they were mostly bare rock. And, of course, I couldn't do much in the mountains.

Like most of these countries, the place was a hereditary sheikhdom. It was presently being ruled by an astonishingly progressive young prince, who devoted most of his income to the building of housing, schools and hospitals for his people. An uncle was mentioned as being an exiled contender. That didn't seem to concern me much, so I skipped that part.

It only took a couple of hours to get there on the zipper, and Smyth met me at the landing site. He fixed me up with a pretty fair building on one of the higher peaks of the foothills. You could see clear across the country from the place, all the way to the border of Burami. He also introduced me to the local ag supervisor, whose name was Medhat. Medhat was a pretty nice bop, tall, with very dark skin and one of those long, hooked noses that are so popular in that part of the world. He was a sort of second cousin to the ruling prince. He also knew next to nothing about agriculture.

"How the dickens do you expect to run an Ag Department unless you know something about ag?" I asked him.

He answered in perfect English. "Who is the man in charge of the Agriculture Department in your esteemed country, Dr. Parker? One of your outstanding farmers?"

The point, I had to admit, was well taken. There hasn't been a real ag man running that show in my country since the early Thirties. So that left it up to me.

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I found myself spending a lot of time with Medhat, mostly in the open, wandering around the countryside. I would explain what I knew of the business, and he would listen with bland interest. Now and then he would suddenly hoist his rifle and pow away at a hawk or something, which I found a little unsettling, but most of the time he was a good audience.

Finally he told me, "It shall be done as you suggest, my friend. The lowlands will yield their harvest." He smiled. "It is a particularly good place to grow things, since it may serve as an object lesson to those idlers across the border. They will see how we practice the arts of peace."

Things moved smoothly. The fertilizer and machinery came in, and Medhat got his bops fixing things up. Those guys loved that machinery, once they conned how it operated. I worked out a simple cycle, starting slow and easy so as not to upset either the land or the people. Every afternoon you could see half the country's population standing in the foothills, watching the unfamiliar rain in the valley. I was a sort of hero to them.

"My people consider you something of a good magician," Medhat told me, his eyes flashing as brightly as his teeth. "They may even start naming their children after you. If my uncle were here, as he was in the bad old days, he would be very jealous."

"No reason for that," I hastily assured him.

"I understand," he agreed. "And so does my cousin. Incidentally, my cousin just received a demand from Burami that the rainfall in the valley must be stopped at once."

"Why?"

"They claim that we are stealing their natural water."

"That's ridiculous," I exploded. "I'm bringing that rain in straight from the gulf. It never even passes over their land."

Medhat shrugged.

"Well, what do you want me to do, close up shop?"

"Oh, by no means," he said earnestly. "As you have explained to me, your service is dedicated to peace. We are interested in peace. Developing our agriculture is certainly a peaceful pursuit. I have discussed this with my cousin, and he insists that it continue."

Nevertheless, the next time I saw Smyth, I asked him about the protest.

"Yes, it's an interesting problem," he replied. "There is no easy solution."

"Do you know when the Russian station is going to be installed in Burami?"

"No. All I know is that it hasn't been started yet. No weather equipment has arrived." He shook his head, frowning. "But the tanks have arrived."

"Tanks? Russian tanks?"

"Uh huh."

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"Does Sharja have any tanks?"

"Oh, no," Smyth said. "We tried that in the past, and it gets much too complicated. There would be too many objections by the other countries around here."

"Well, what about those that Burami just got?"

Smyth shrugged. "Looks like a problem for the UN."

"It could take forever there."

This apparently irritated Smyth. He said sharply, "I doubt if you understand these things, Doctor. Perhaps you should stick to your weather control and leave the diplomacy to me."

Three days later, you could see a lot of dust rising from across the border. I got my binoculars out, and sure enough, there were a lot of light tanks moving around. They looked like they might be going somewhere.

Nobody had been doing any shooting along that border for some time, but I got on the radio link to Smyth's hotel right away. He was out. Shortly after, however, Medhat came riding up. He wasn't smiling this time.

"Just this morning, your friend Smyth and my cousin departed for the UN in the zipper rocket," he told me. "Envoy Smyth had high hopes of settling our difficulties with Burami there."

I said, "From the looks of those tanks, it's going to take more than talk."

"Yes. Unfortunately, my uncle has seized this opportunity to regain his throne. He has made a pact with Burami. Since he admittedly has a certain hereditary authority in this land, the Burami army now enters under the guise of a more-or-less legal invitation. If my uncle succeeds in reaching the mountains, it will be difficult to drive him out in the future. In time, he will be recognized as ruler."

"Can he get away with that?"

"He has tanks and my men have nothing but rifles and an occasional mortar," Medhat said simply. "This is an ancient way of voting."

I uttered a few choice words about Smyth and his grand, complicated diplomacy, which left Sharja without suitable defense. I added a few for his being absent at this time. He was supposed to be my adviser and guide, and right then I needed some advice and guidance badly. Finally, I asked Medhat if he thought I should leave the country for a while.

"I am afraid that may prove difficult," he said. "My uncle already has taken the zipper rocket site. Even if you are able to cross the mountains you will be a stranger in a foreign land where you may not be welcome. And, of course, there are bandits. My suggestion would be to stay with my people in the mountains, except that you will then share their fate."

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"Fate? And what will that be?"

"If my uncle is successful, they will become slaves again."

I considered the chances of Smyth getting me out of that situation by diplomacy. Having observed the results of his skills, I decided that prayer would be more useful.

We stood for a few minutes, looking down into the lowlands, watching the tanks as they began to move across the border into the knee-high rye grass that was growing there as a first crop. People were hurrying by us on the rocky roads, seeking the refuge of the mountains behind.

"What are you going to do?"

"We will resist, of course," Medhat said grimly. "I have loyal men, even if they have inadequate arms. The tanks are light tanks, which gives us some small chance to hold them in the foothills. My cousin will return shortly, and he may be able to get help. He is well-liked in some of the nearby countries."

It did not strike me as a very optimistic prospect, and I said so.

Medhat agreed immediately. He hesitated a moment, then commented, "A thought has crossed my mind that your weather-controlling machine is a great marvel of modern technology."

"It certainly is," I said.

"It can make rain," said Medhat softly. "It could even make storms, is that not so? Great storms?"

"Under the right circumstances," I admitted.

Medhat cleared his throat. He said, "I realize that your Service is dedicated solely to peace, my friend. So have we been. But now war is thrust upon us from outside."

"I can't do it, Med," I said.

Ignoring my comment, he insisted, "You could conjure up a great tornado against these bandits. You could sweep them all into the very gulf if you desired."

"I can't do it, Med," I repeated. "Please understand me. I wish I could help you, but I can't. Sure I could probably scare up a tornado, but what's to prevent it from destroying you and your people as well as the tanks? Or instead of the tanks? I simply can't control a storm like that. Nobody can. All we can do in that direction is to prevent them from forming."

He caught his breath, turned away and nodded. "Yes," he said quietly. "Of course. It was wrong of me to ask it of you."

He turned back to me, and I could see that it was costing him an effort, but he smiled and gravely shook my hand.

"I understand, my friend. You have your limitations as I have mine. It was just that you can make it rain a little bit, and anyone who can do that somehow resembles a god to me. If only," he added humorously, "a small god."

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I grinned at him and said, "Some god."

He started to leave, but a light barrage broke out below us, as the first tanks reached the foothills. It sounded vaguely like thunder in that small valley.

"It is a strange time for destruction to start," Medhat said. "See, your afternoon rain is about to descend. In the ancient days, the coincidence would be regarded as an omen."

I looked up and sure enough, the moderate clouds were gathering for the daily watering of the fields—the fields were now being plowed up by all those tanks. It set me to thinking.

You can get in trouble thinking. My best bet was to stay out of sight, do nothing, and wait for the situation to clear up. Even if Uncle didn't approve of my presence there, he wasn't likely to shoot me. In a few years, I could expect to get out again, perhaps.

But there was another thing that bothered me. I liked these people and figured they were getting a rotten deal. I couldn't strike their enemy with a giant storm, as Medhat had hoped, but there were other methods. What I had in mind probably wouldn't be acceptable to Smyth. Smyth, however, wasn't there. I was.

"Hold it Med," I said sharply. He had started away, but he returned when I spoke.

"Med, the Weather Service is strictly for peace. You understand that, don't you? I can't have anything to do with a war."

"Yes, yes. So?"

I considered my selection of words. A certain diplomatic double-think was appropriate.

"So this," I said. "In this country, you are my super. I have to do what you tell me to do, just as long as it comes within the normal function of the Service. Now it so happens that if you can get the people away from those lower foothills—"

"They have already left," Medhat interrupted impatiently.

"Good. Then, if you insist that I irrigate the foothills instead of the rye fields, I'd have to do what you say."

"It would be a waste of time," he returned shortly. "Nothing grows in the foothills. There is nothing there but bare rock and some dwellings."

"And roads, Med. Three roads. The only way those tanks can get up here through that rough terrain is on three roads."

He frowned. "This is true," he said.

"Those roads are cut in the solid rock, they are narrow, winding, and in most places two to three meters deep. Did your people cut those roads that deep? Or did God —Allah?"

It didn't take Medhat long to catch on. He hurried off at once to give instructions to his men, and

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I returned to my control room. I didn't have much time.

In that first interview with the chief, he had asked me for an abort sequence to keep a hypothetical diplomatic reception dry. I hadn't known the answer offhand, and he made me squirm for it. But he also made his point. Like a boy scout, a weather operative was supposed to be prepared for any emergency. And I had done a lot of studying since then.

I got to work on the charts at once. The weather elements in that part of the world were well-mapped, even though in general no control was used. There was adequate reserve, I found, to back up the probabilities already established in the region. It merely remained for me to use a stock program to direct the operation.

I spent about ten minutes checking my calculations, then hopped on the TT and sang my little song to the satellites.

And the satellites responded, as laser and phaser went into action along a two-hundred kilometer front. Slowly moving masses of moist air were prodded into more purposive activity. Updrafts developed where none had been, then were quickly deflected by cross currents. The clouds built up over the foothills, spread out, became a general overcast, and the rain began to fall.

At first the tanks paid no attention to it. What's a light rain to a tank anyway? They were well up into the lower foothills by then, blasting away occasionally at Medhat's men. They continued to wind their way up those three narrow, rocky roads, rain or no rain.

As Medhat had pointed out, the foothills were mostly bare rock. They could be depended upon to absorb perhaps three to five percent of the precipitation.

I had made my estimates carefully, but it didn't take a lot of advanced math to figure out what must happen. The rain was coming down at around two centimeters per hour—less than an inch, as they used to say. Hardly a cloudburst. This was falling on a projected surface of roughly eight kilometers by thirty kilometers. The whole affair was pretty small scale right from the beginning.

All this, however, came to approximately two million cubic meters of water per hour, which must go somewhere. Since the roads were ancient riverbeds, carved in the rock some thousands of years earlier when the climate had been different, it could be expected that they would still provide most of the drainage automatically. There was about a hundred and fifty meters fall in average surface elevation, and this would control the velocity of the runoff.

If my estimates were correct, the input-output conditions were just about right to keep those roads pretty full for the duration.

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I didn't have time to watch. My hands were occupied keeping track of the situation in the upper atmosphere. If I under-did things, and the rain slackened off, there would be no significant advantage accrued. If I overdid it, it would turn into a flash flood, and anybody in or near those roads would be killed. I didn't want to see a lot of dead bodies around when this was over.

It was about two hours later when the door banged open. Medhat sloshed in, leaking water like an oversized dishrag, but he was grinning from ear to ear.

"Enough, enough," he shouted. "You will wash us all into the gulf if you keep this up."

"What's going on down there?" I shouted back. The rain was making quite a bit of noise.

"Nothing is going on down there. The tanks were not designed to operate at the bottom of a river. And I have a lot of very soggy prisoners who would like a chance to dry off."

I grinned and moved back to the TT. There I pounded out a message to the satellites, telling them that no further irrigation was needed in the foothills that day.

You can't keep a thing like that quiet, of course. Not with fifty Russian-made tanks stalled in the foothills without a mark on them, except for some water stains. Quite a few visitors from the nearby countries came to view the sights. One of them was a high-ranking Russian military observer. I didn't see him myself, but Medhat said he seemed a little ill-tempered.

For about a week afterward, I kept getting all the foreign newsy tapes and checked them over carefully. I was looking for the part where the Kremlin denounces the U. S. Weather Service as a worse international menace than the old CIA. But for some reason it didn't appear.

One thing that did appear, though, was an article saying that the Kremlin was holding up all future arms shipments to the area indefinitely. Instead, they were starting a new program to protect the local people from the capitalistic imperialists. They were going to ship in a lot of weather-control stations, complete with Russian operating teams. They also claimed that U. S. weather operatives were extremely inferior.

That was the day I got the cable from Hagen. It said that if I kept up my performance, I might make permanent status someday. Meanwhile, I was to be in charge of a special Presidential mission to counter the Russian move.

And guess who was shipped out to be my new secretary?

Man, it was bliss. ■

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STIMULUS-RESPONSE

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The basis of all learning seems to be stimulus, and response, and reward. Training builds up successful strategies—provided you have some degree of success to start with!

HERBERT JACOB BERNSTEIN

Illustrated by Kelly Freas

Toby stretched himself awake. He savored the delicious warmth of the old steam radiator against his back, the scent of his territory and of his master. The hazy grays of his mat showing just past the ear covering his left eye reassured him that all was safe and secured. Though hunger tempted him to rise, the effort of staying awake was too much, and he slowly drifted back to his dreams.

Dr. Harold Robbins watched his beagle's losing battle against psychic inertia with mixed feelings of amusement and mild guilt. The hound was strangely human in his antics, and deserved to be left to rest in comfort—he looked so content on his red and yellow crazy quilt. But Dr. Robbins needed Toby as a guinea pig, so Toby would have to forfeit some sleep.

Harold's residents at the hospital often chided him for using a pet in experiments. Dr. Hostler, Peter Frontley Hostler, a thirty-year-old mistake from West Virginia Southern Memorial, a second-year resident in psychiatry in need for a heart implant, often complained, "You never let us finish our work. To report properly, we must sacrifice the subjects so that we may section and examine the neural tissues for pathology—especially that dog!"

The more reasonable ones, such as Dr. Chun—Harold could never recall her first name, nor whether it was her first name or last that he was forgetting—merely noted that "it would be better experimental practice to work only with laboratory animals," instead of disturbing an old friend. In order to win her over to his point of view, Harold had bought her a small turtle as a pet.

What they did not understand was that lab animals required a requisition, a requisition required the signature of Frank Kenny, the hospital administrator, and Frank

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Kenny required a detailed research proposal before he would O.K. so much as a brown mouse, much less a pigeon. Indeed, Frank's proposal standards seemed to demand a firm prediction of the results of an experiment before it could be run. Harold had even managed to use one Kenny-approved proposal as a final report.

When he was younger, and even brasher than Peter Hostler, Harold had tried to explain to Frank that the whole purpose of some psychological experiments was to give yourself hints about the right approach to the next one. He had planned a psychodrama of what he thought to be great persuasiveness. Harold's role was that of dedicated harried physician, two days of stubble on his face, sweat soaked, blood spattered green scrub suit plastered to his lanky frame, a distant look in his eyes provided by removing his glasses.

Storming past Frank's receptionist, he had tried to put the administrator into the role of the naïve layman stopping the progress of vital scientific research. But after letting Harold rant and rave for a quarter of an hour, Frank had calmly and competently quoted the provisions of the World Institutes of Health contract covering dispersements of research funds. Harold then had tried to suggest that some way around the legalisms might be found. Mr. Kenny's reaction to Dr. Robbins' suggestion had provided massive material for a study on mental blocks, but no improvement in the situation.

Even the simple equipment needed for home experimentation had been obtained by subterfuge. The magnetoencephalograph he used on himself and Toby had been the hard part.

As a licensed physician, Harold naturally owned an electroencephalograph, just in case he were ever asked to certify a body as irrecoverably dead. The small reddish-brown plastic case on the hip of his tunic marked him as a physician much as the black leader bag and stethoscope had distinguished his teachers in their time. He and Toby still had networks of bald spots on their heads from numerous past experiments. Dr. Robbins' classic monograph, "Fear as Evidenced by Cerebral Potentials," had sprung from a study of Toby's first reaction to the EEG.

The magnetoencephalograph, on the other hand, was not such a burden on the subject. Normally it was used by hospital emergency teams for mass screenings at slipway accidents and cave-ins. The heart of this device was a three-dimensional array of magneto-transducers connected to a small computer. By analyzing the time variations in the magnetic field within its volume, the magneto-encephalograph could deduce the changes in electrical activity at any

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point in space within a large volume around it. Resolution was sufficiently good, that an emergency team could select the living from the dead within seconds, even when hundreds of bodies were involved, or locate buried commuters scattered along miles of slipway belt.

With the aid of only slightly improved computational facilities, the magnetoencephalograph could be used to monitor the cerebral activity of a moving subject, and thus was invaluable in psychomotor studies. It was becoming standard practice in larger hospitals to devote a portion of the patient monitoring and accounting computer capacity to MEG's used in this manner for research and ambulatory intensive care.

As with all such devices of great utility, there was a price to be paid for the convenience offered—over 200,000 cru, cash, in advance. Harold could dispense with the extra computer for subject tracking, his household computer, a B9, was more than up to the task, but the basic magnetotransducers alone ran over 150,000 cru for even coarse resolution. This was understandable, in view of the painstaking hand-weaving process used in the creation of a reliable set; but he did not like the idea of parting with three years' earnings. Naturally, Harold decided to have the hospital provide a MEG for him.

"Frank," he asked Kenny one day, "how long does it take one of our emergency teams to reach the fringes of our area of responsibility? Say, the South Bay Escarpment." Harold tried to make the question sound innocent by concentrating on the portrait of Hippocrates behind Kenny, as if that worthy were to answer.

"From five to seven minutes after notification," was the administrator's prompt reply, as he turned to check on what could be so fascinating behind him. Kenny had just completed his latest fund-raising tour, and had all the figures firmly in mind.

"Wouldn't it help if they could arrive to find the body scan already initiated?" Harold suggested to Hippocrates with his fingers crossed.

"Sure, but they can't start until they're within at most four miles. And by then they're decelerating so sharply, resolution falls off by a factor of ten." Frank's stomach rebelled at the mere thought of such a trip, and he had been on only one. By this time he had identified the focus of Harold's attention, and found himself drawn to the old Grecian face.

Frank's and Harold's remarks were both being directed to the founder of modern medical practice and assumed an aspect of ritual chant.

"Then, why not spot MEG's in the outlying areas? Set them up for automatic activation and body mapping in the desired sector on signal from Hospcom, and have them re-

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lay the maps to the emergency teams in flight."

"Hm-m-m. It would involve an additional wide-band com-channel to the team flitter and a revision of their on-board programming to handle the data stream; but it sounds interesting." Frank broke the Hippocratic spell, caught Harold's eye, and asked him, "What do you get out of it?"

Trying to imitate that look of wounded ego Toby used so well on him, Harold replied, "Only the pleasure of knowing a few more human lives have been spared centuries, possibly an eternity, in the freezer."

Finding it impossible to imagine a halo anywhere near Dr. Robbins' head, Frank pried for details, until Harold offered his home as one of the sites for a MEG. That satisfied the administrator. He gladly accepted the offer, since he knew that Dr. Robbins would maintain the equipment in top condition, and Harold's charge for the use of his property was quite reasonable—Harold even agreed to test the MEG frequently for a slight additional fee. Frank knew very well that the "testing" would consist of experiments with Toby, but was certain that would serve the purpose just as well as a standard series of diagnostics. Thus, finally having Harold's interest in this good idea pinned down, Frank was able to relax, and the MEG was soon installed in Harold's home.

That morning's test consisted of a variation on some of the mid-twentieth century work done on activation of external processes by control of the mental state. In the earliest experiments an EEG had been connected to a subject and some gross characteristics, say frequency or amplitude, of cerebral electrical activity had been used to determine whether a light should be on or off. With some practice, subjects had been able to consciously switch the light on, or switch the light off. In some experiments, a degree of control of the intensity of a tone or a light had been achieved. Little had been done since.

Dr. Robbins, being out of fresh ideas, had decided to look more closely into this old one. If he could get Toby awake, the hound would be hungry. He had set the MEG and his household computer to track and record Toby's neural activity. He had programmed the B9 to pick out the hundred most repeated prominent patterns from this data—indicating both the pattern and its location within the dog's brain. He would then choose one of these patterns as a key to the control of Toby's autofeeder. But first he had to get that lazy beagle up.

Toby was already half awake when he felt the tug of the leash on his collar. His master clearly wanted to play a game of "pull." This was an easy game. Toby made himself very limp and let his master

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pull him and his mat around the room. He even got some more sleep.

Dr. Robbins was nearly exhausted by the time he got Toby over to the autofeeder. There were times when he thought that beagle was naturally perverse, and times when he was sure of it. His shoulder was nearly out of its socket, but Toby looked like he was enjoying the ride on his mat, despite the fact that the entire mass was being pulled by the collar around his neck. Harold put the autofeeder on manual, initiated the MEG program in the household computer, and had the autofeeder exude essence of pure beef. He couldn't smell a thing, but it had a definite effect on the dog.

Toby became aware of a scent long familiar, yet always new. Gradually the stirrings of hunger in his gut gained momentum. He could no longer rest. He must eat. He could already feel the meat between his jaws, bits of it working their way deeper in as he chewed. Before he was even on his paws, he was mentally pushing the button he would have to work with his left front paw to trigger the autofeeder. Then he was fully awake and pushing hard on the button, but the food did not appear. He pushed harder, and harder. The button sank deep into its socket, the limits of its normal travel far exceeded. Vaguely he noticed his master do something to the autofeeder. The food came.

Having flipped the autofeeder back to automatic operation—he could no longer stand to watch Toby's futile lunges at the button, and Hospcom had pre-empted the MEG—Harold went over to the B9's console to see if it had detected any persistent patterns in the output from the MEG while it had been on Toby. For sheer volume the data was impressive. Over a thousand clear patterns had been detected by the household computer in various regions of Toby's brain.

Harold accepted the computer's judgment as to the hundred most prominent, and, after the beagle had gone back to sleep, rigged the B9 to operate a solenoid under Toby's autofeeder button. This would cause visible motion in the button, which might help the hound get the idea. It also was the easiest way to interface the sophisticated electronics of the computer with the brute mechanical construction of the autofeeder. When Toby thought in such a manner that the MEG fed the B9 one of the hundred patterns, the computer would generate a long pulse of high amplitude in the solenoid circuit, the solenoid would pull the button down from below, and a dog's dinner would appear. Finally, in order to keep Toby from lousing it up by just pushing the button himself, Harold glued a big inverted glass bowl over the button.

By perusing the computer's records of the MEG track on Toby,

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Dr. Robbins could find the length of time it took the dog to operate the feeder in this manner, and the amount of wasted mental effort needed to find the right pattern. The collected statistics would form the basis of a proposal for research to be carried out by Drs. Hostler, Chun, and himself. At the moment he had those two residents doing the library work for the project.

It worked beautifully. At first, Toby would go over to the autofeeder, try to push the button through the glass bowl, and watch in amazement as the button slowly drew itself down. After several days he would merely walk over to the autofeeder and stare the button down. Within two weeks it got to the point where he seemed to be paying no attention to the button at all, but merely thought in a certain way as he strolled over, fully expecting the food to be waiting. He was right.

Harold tried to make things harder by reducing the number of acceptable patterns, but Toby adjusted almost immediately. The doctor tried random selection of one pattern, which would change daily. It did not faze pensive Toby. It was getting to be a challenge to Dr. Robbins to find a technique the dog could not adjust to. First, however, he had to find out if Toby were unique. It was time for careful lab experiments. He certainly had enough data to get a proposal past Mr. Kenny.

A week after he submitted the proposal, Frank asked him to drop over to discuss it.

"This is a nicely worked out experiment," Frank began. "I suppose our magnetoencephalograph and your dog were put through a wringer developing it."

"True," Harold replied, "but with more damage to me than to either of them. I think I've soldered and clipped more skin than wires. If you would let me do such preliminary work with hospital facilities, some masochistic resident could collect the scars, not me."

"We've been through this before. I can let you lock two residents in the library as part of their training —that involves no special funds— but I cannot make a budget entry without proper documentation, or the auditors would have me on the carpet. Now that you've done the necessary paper work I can let you use hospital facilities."

"O.K., what will your PERT network heart let me have?"

Frank let him have two white mice, a rabbit, and an elderly Airedale, along with a large time slice on the hospital's MEG-computational facilities, a few gigawords of data storage capacity, petty cash for wiring, and a stern warning that "any human 'volunteers' had better be named Robbins, Chun, or Hostler" to avoid repetitions of unfortunate past misadventures with patients who had not quite understood to what they were agreeing.

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Harold used the standard Skinner-box feeders left over from some earlier experiments, and assigned Hostler and Chun to do the actual work. The results were unspectacularly uniform.

All the experimental animals did as well as Toby—even Dr. Chun's pet turtle and the three experimenters themselves had no trouble in —with a little practice—running through a series of mental patterns very quickly. The MEG records indicated that Toby, the other animals, and the doctors all ran through almost all the patterns picked up during the initial data collection. It was almost like some small child, who, having discovered that sucking his thumb, then picking his nose, then passing his hand before the photolock, then counting to ten, opens a door, might continually go through the same simple ritual every time he wished to open a door, unless someone told him otherwise. On the other hand, such a thing rarely happened if the door had a knob instead of a slow-action safety photolock. The feedback of the door actually moving in response to the child's actions with the knob would tend to isolate just that portion of the ritual as the crucial one.

Late one night Drs. Robbins, Chun, and Hostler met with Toby in Harold's house to discuss their progress over dinner. They sat around a fine old table of white ash: Dr. Robbins at the head, Dr. Chun to his right, Toby on the floor to his left, and Dr. Hostler at the foot. They ate brownish yellow fillet of flounder from rough gray china set on deep-red place mats. All were more intent on their meal than anything else, but they managed to speak on occasion.

"First honest meal in six weeks," Hostler growled. "Shame to waste any on your hound."

"He's been living off autofeeder and Skinner-box food like the rest of us," Harold replied gently. "Besides, I think he prefers his usual automated meals, and is eating with us just out of courtesy."

"To tell the truth," Dr. Chun interjected, "I also like the magic of thinking a meal out of a box—no offense to this very honorable fish intended."

Liking the friendly tone of the girl's voice, Toby moved under the table to panhandle some extra food from her. Unfortunately, he informed Dr. Chun of his presence by nudging the back of her bare left knee with his rather cold nose. Dr. Chun gave voice to a small shrill squeak, rose six inches in her seat, turned accusingly towards Harold, and then looked under the table when she saw him to be as perplexed as she.

"Toby," she said sternly to the obvious culprit, "you are putting a definite strain on our friendship," and slipped him a bit of her fish.

"Now that's the sort of clear-cut

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stimulus-response pattern we need in our work," Harold remarked after sizing up the situation, and swallowing the bit of potato he had been chewing during the incident.

Feeling left out of the conversation and upstaged by a dog he did not like, Peter Hostler said, "Wishful thinking aside, we've got significant data. Let's publish it and move on to something else."

Dr. Chun gave an almost involuntary nod of agreement.

"You're both right about publishing," Harold agreed, "but we are not finished with this project. As I see it, we have trained several animals, and ourselves, to give an almost spastic mental response to hunger. Such training might be useful in some unrefined control situations, such as triggering emergency shutdowns in a power plant, or destruct mechanisms in a military spy flitter, or calling for police or emergency team assistance near any city. We should publish so such things will be tried. However, it is not unreasonable to expect that we shall be able to create a refined, detailed, precise mental response to any given stimulus, response akin to muscular control. I expect you two to get to work on drafts of what we've got, but I also want ideas on how to do better."

"Right now we're giving an all-or-nothing reward for the correct response," Peter Hostler remarked. "If we graded the type and quantity of food to the variation of the actual response around the ideal, we should encourage more detailed control."

Dr. Chun did not like the idea. "It's a possibility, but expensive in terms of hardware and not very good for experimental purposes. The results will then depend on individual idiosyncrasies too much. In the words of Mao, 'We must march to the heart of the conflict.' Direct intracranial stimuli are needed." She spoke with great feeling and came near to upsetting the table and Toby. The beagle decided to seek the comfort of being near his master and curled up on Dr. Robbins' feet.

Harold freed a foot to stroke Toby's back. "Dr. Chun, you're right. Stimuli on the same time scale as the behavior pattern are the ideal solution, and that means stimuli applied to the ganglia involved. But ideals must often give way to pragmatics. I think we'll have to settle for visual, or auditory, stimuli as past experimenters in this field have done, and allow the few tens of milliseconds transmission lag."

"Nonsense," Peter Hostler snorted, "just drill a few holes in that dog's skull, push probes in, and we can tickle every neuron . . ."

"Hostler," Harold growled, "if you keep talking that way, you'll have a Swiss cheese skull." He quickly recovered his temper, and continued mildly, "Besides, Toby

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has too few working synapses as it is."

"Also, we three noble experimenters should be able to join in the fun without having to plug our heads in," Dr. Chun said.

"Well, do either of you have any better ideas?" Peter felt on the defensive. "Maybe the genius on the floor has an answer. Why don't we ask him?"

Dr. Hostler leaned to one side low enough to see Toby under the other end of the table, and snapped, "Tell us what to do, you nitwit!"

Toby knew the command, "Tell." So he told—in a loud continuing bay, trying to keep pace with the rhythm of Dr. Hostler's voice.

As the dog's noises grew louder and better keyed to his own inflection, Peter found himself almost shouting. His two dinner companions were shaking with laughter, and this seemed to encourage Toby. Where the dog matched Dr. Hostler exactly, he found himself repeating words.

"How the hell hell hell do you expect expectpect expect me to talk talk?" he asked Toby at the top of his lungs. Toby politely continued his end of the conversation, while Peter turned red with rage and embarrassment, and Drs. Robbins and Chun turned purple with mirth. Seeing it was hopeless trying to argue with Toby, Peter lapsed into silence, Harold and Dr. Chun ran out of steam, and Toby petered out to a fast pant.

"Dr. Hostler," Harold said with an occasional chortle, "your manifold sins are forgiven. You have not only given us a good laugh, I believe you have given me that 'better idea' you wanted. What you just went through is a variant on the 'delayed speech' test of the early days of audiometry. It was before your time, but before EEG's were made a standard part of hearing tests, some people would try to feign deafness for monetary gain, or might have a 'functional' deafness due to some personality disorder. One of the effective ways of detecting the more extreme cases was to feed back the patient's own voice to him with a slight delay as he tried to read a page of text aloud. When he could hear the feedback he would raise his voice, or slow down, or stutter. To read aloud at all when hearing a delayed echo of your own voice you've got to concentrate fiercely on what you're doing. I know. I've tried it. Apparently, the quality of the echo need not be very good. Witness what in-Toby's-ears-out-Toby's-mouth, a lousy delay loop, did to you."

"All well and good," interjected Dr. Hostler, "but what has that got to do with . . ."

"Please do not interrupt, Dr. Robbins," Dr. Chun interrupted, "I am interested, and I think I see the point. Make the MEG give as good as it gets."

"As Dr. Chun seems to have

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guessed," Harold continued, "I'd like to try using a magnetic echo from the MEG. Look, the transducers of the MEG are just thousands of coils of wire. When magnetic lines of force—blessed be the physicist who invented that abstraction—cut the coils, currents are generated which are interpreted by the computer circuitry to infer the currents needed to generate such fields and the location of their source. There is no reason why the technique could not be reversed and a MEG used to induce desired currents in some other circuits—say the nerve cells of Toby's brain. In general this would be very difficult to program, but it would be easy to have the MEG devote a portion of its transducers to echoing back into the source of a given pattern, a copy—of any intensity or polarity—of that same pattern. In effect, the MEG could be made to shout back louder and louder as the patterns get closer to the desired one."

"Nuts," said Dr. Peter Frontley Hostler, "probes are easier."

"You can drill holes in your worthy cranium, if you wish," Dr. Chun rejoined, "I like this idea."

"Nuts," Peter repeated.

"Then we're all agreed," Harold said cheerily. "Finish eating and we'll get down to details over coffee."

They planned with care, and, as usual, Harold decided to make Toby the test case. Several mornings later, Toby woke to find changes in his world. When he approached the autofeeder, it was not open. As he stood there puzzling this out, he found that at times it was even harder than usual to think —he had to make some effort. It was sort of an itch that had to be scratched, and the more he "scratched" the more scratchable it got—until suddenly it was gone, and the autofeeder was open. Feeling a bit put out, Toby sullenly wolfed down his daily steak.

Dr. Robbins watched this episode with relief. The change had worked. The household computer had been programmed to cause the magnetoencephalograph to echo on a pattern Toby only rarely used, to echo it with greater and greater intensity, the closer Toby got. Harold quickly contacted Drs. Chun and Hostler to tell them they were about to go back to Skinner box food. If they achieved good control, they should soon be able to dispense with hunger as an initial stimulus, but it was a convenient starting point. Just to increase that stimulus, Harold skipped his breakfast, and took his flitter to the hospital with a growling stomach.

Drs. Chun and Hostler had also skipped breakfast for the same reason, and with hunger as a spur to drive them, they managed to complete the laboratory version in time for a late lunch of automated food. Except for Dr. Chun's turtle, and

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Dr. Hostler, the animals and experimenters managed to respond to the feedback without trouble. Peter Frontley Hostler got his meal only after a great effort, and complained of a bad headache. The turtle took several hours to get the idea, but finally joined the rest of the group for dinner.

They practiced for weeks, and all gained facility. They could match more and more unusual patterns quickly and efficiently—adjusting a ramp here, a phase there, a delay in another place—until the feedback peaked and died. They even tried patterns in the vocal and motor areas. Dr. Chun, who had a good voice, and Harold, who had a lousy one, trained themselves to do perfect quarter-tone scales by having Peter record the patterns associated with the correct notes when they happened to hit them, and then using the MEG to provide coaching the rest of the time. At one point they brought in Toby and taught him to give fairly pure-toned bays and howls, though they had to stop that when Frank Kenny informed Harold that the hospital's soundproofing was inadequate and other labs were complaining.

Their results were clean and consistent. Toby was the first to behave anomalously. Harold had been choosing random patterns to control the dog's autofeeder. As usual, Toby would approach the autofeeder, concentrate a little, the button would go down, and the door would open. But the records now indicated no correlation between what Toby was thinking and the chosen pattern, though Toby seemed to be going through the same search-and-adjust procedure as in the past.

Each morning Toby woke happily. He knew he could get his food just by concentrating, like working his paw muscles against a heavy chair. Pushing harder and harder until the chair broke free and moved. It was almost as delicious as stretching, and he could do that at the same time.

Harold was annoyed. He pored over the code he had given the B9, certain he would find some minor bug that was causing it to accept a special wrong pattern. Since he was using similar code at the hospital, Harold warned his residents to watch out for this problem. But there was nothing he could find wrong with his programming, so he visiphoned Frank.

"Frank," Harold began, "I've got the MEG giving me spurious responses, and I cannot discover any error in my programming . . ."

"I know, I've been talking to your residents. You want a repair crew out to check the hardware, right?"

"Right. It could be my code, but it feels more like a micrologic fault. If we could eliminate that possibility, I would feel better."

"O.K.," Frank said soothingly, "I can justify it as a routine inspec-

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tion of hospital equipment—that's our magnetoencephalograph, you know. I'll even have them bring along a portable version of your B9, so you can see if the bug is in your household computer; but if it is, you'll pay for any repairs."

"Many thanks," Harold sighed as he disconnected. He had been afraid Frank would be stuffy about it.

In expectation of the hospital repair crew, Harold disconnected the MEG and the B9 from the autofeeder, and removed the bowl over the button, lest Toby starve. He made it a point to be around when the hound discovered the improvement.

Toby woke in his usual slow-moving good spirits. He woke, stretched, fell asleep again, woke, and walked over to the autofeeder concentrating fiercely. He noticed something strange about the autofeeder, but was too intent on concentrating for his food to pay much attention. The mental pressure grew stronger, peaked, and broke. His food appeared. As he ate with the good appetite of the well exercised, he finally figured out that the bowl was gone. But before he could work out any logical implications of this fact, his master broke the delicate chain of thought by getting down on the floor and pulling the button apart. It was very entertaining.

Though he did not really believe it, Dr. Robbins told himself that he had failed to totally disconnect the solenoid under the button from the MEG-B9 computer setup. This time he physically removed the solenoid. Later that day the hospital repair crew gave the MEG a clean bill of health, and Toby repeated his actions with the portable B9 in place of the household computer with the same impossible results. The repair crew was so impressed by the "magic" they forgot to hint for their customary tip, though Harold upheld tradition by slipping a few cru into their tool kits.

Harold was forced to the conclusion that he did not understand his experiments as well as he thought he had. By all external evidence, he had trained a poltergeist, a canine telekineticist, and might well be training a whole menagerie of such, including three human beings and a turtle. But, if the attitude of the repair men was typical, he would have a hard time convincing anyone that no sleight of hand was involved. He needed time, and more poltergeists. He needed solid experimental evidence. But he could not picture Frank Kenny accepting a research proposal entitled, "A Study of the Supernatural Phenomena Exhibited by my Beagle." He would have to divert the present experiment in that direction, without letting Frank or his residents know, until the evidence was unshakable.

"Frank," he lied to Kenny, "I

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pinned down the cause of the spurious responses."

"Not our equipment, I hope."

"No, just a trivial wiring error on my part. Your people's eliminating the possibility of machine failure narrowed it down to my interconnections. I told you a resident should do it. Chun and Hostler didn't make such mistakes in the lab wiring . . ."

"Not that again," Frank complained.

"O.K., I've taken enough of your time. The problem's solved and all is well," Harold said pleasantly as he disconnected. He felt sure Frank would be sufficiently piqued to avoid poking his nose into the state of his research for a few weeks. Harold then squeezed himself and tapes of the patterns Toby had been using into his flitter and got to the hospital in record time.

Peter Hostler was nowhere to be found, but Dr. Chun was asleep on a cot in the lab when Harold finally looked there. After harrumphing, coughing, and clomping around for a few minutes, Harold got impatient with civil ways of waking the sleeping resident, took matters firmly in hand—the foot of the cot to be specific—and shook Dr. Chun awake.

"Rise and shine, sleeping beauty," he said to her feet, "there's work to be done."

"For shame," she teased, "attacking a defenseless woman." Dr. Chun rose, checked her hair and tunic, sat down on the cot and waited. Dr. Robbins was obviously determined, fiercely determined, to do something. The last time she had seen a male in such a state, it had been preparatory to a marriage proposal, but that "there's work to be done" sounded discouragingly professional.

"Where's Peter?" Harold asked sharply.

That ended Dr. Chun's romantic speculations. "Covering an open slot in E-team three. I think he wanted an excuse to eat their rations instead of our worthy essence of Skinner."

"The coward. Well, we'll just have to get along without him. Forget everything I told you about my troubles with Toby. That problem is solved. We're going on an intensive training schedule with the setup as we have it now, but with a few improvements. Cut the food output of the Skinner boxes to the absolute minimum. Block part of the feed slot if you have to. I want every animal in this lab to spend more energy getting food out of our MEG than they get from eating it. I'll type in the revised programs. We are going to practice shaping mental patterns till we drop."

"I had thought we were doing just that, honorable slave driver," Dr. Chun giggled as she went to work on the turtle's feeder, leaving it a bit above the minimum, since she felt the turtle was a bit under-

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nourished. On the rest, she followed orders, making the Skinner boxes little better than teases, completely removing the food supply from Harold's and hers.

While she was working, Harold made some changes in the pattern selection algorithm, making a wider and faster random variation around patterns similar to Toby's. He also wired a bypass from one of the output buses to a Hospcom paging terminal, and added a special trapping routine to the programs.

For most of the animals the feeding pace picked up to several times an hour. The Airedale, Dr. Chun, the turtle, and Dr. Robbins seemed to be tripping the MEG once or twice a minute, more for the hell of it than for food.

In two hours the experimenters were soaked in sweat, the Airedale was asleep with signs of heat prostration and indigestion, and the turtle was busily eating his way into a steadily growing pile of food. Harold had trapped the programs to signal him via his paging bleeper when a Skinner box was operated without benefit of a signal from the computer complex. He was feeling very tired and frustrated when the signal went off as Dr. Hostler's box operated, and Peter walked in complaining "That's some setting you picked for me. I spent the last ten minutes in the hall trying to trip my feeder. And it didn't feel right when I did . . ."

"Shut up . . . no, don't shut up —do it again," Harold babbled. "Dr. Chun, retrieve the pattern he used from the data banks, fast, before the machine goes down, or the world ends or something. You'll find it flagged with the associative identifier T-O-B-Y. Do it again Dr. Hostler, do it again."

Peter did it again, and again, though he wondered why Dr. Robbins was ignoring a very insistent page.

Dr. Chun came over looking very puzzled and interrupted, "There's something wrong. Pardon me for not forgetting orders, but this is just like what you said you were running into with Toby. The pattern Peter used is nowhere near what the computer wanted."

"Pay no attention to her, my boy," Harold said pleasantly. "Keep practicing, and I'll disconnect the food supply, so we don't end up buried like that turtle under a heap of food."

Peter nodded agreement and kept working, while Harold went over to Peter's Skinner box and not only disconnected the food supply, but the leads from the computer conduit as well. He motioned Dr. Chun to come see his handiwork.

"Are you two playing some sort of game?" she asked.

"Not at all. Peter, come here and examine the state of the mechanism you have just been operating."

Thoroughly befuddled by the last remarks, Dr. Hostler gave his Skin-

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ner box one last mental push and went over to see what the fuss was about. It took him a few minutes to see what was different. To check himself he gave the box repeated mental jabs while opening its back to completely remove the solenoid attached to the actuating arm.

"That's just what I did when Toby displayed your symptoms," Harold remarked. "You are now the second scientifically trained telekineticist. Toby beat you out for first honors. Now all we have to do is figure out what we trained you to do."

"Hogwash," Peter said, "you're rigging it somehow. Maybe with an embedded magnet and a strong external field controlled by a MEG with a computer set for another pattern. I don't know exactly how yet, but you're rigging it." Peter wasn't sure whether the idea of what he was doing, or the fact that the beagle had been doing it first, upset him more.

"I tend to agree with Peter," Dr. Chun said. "For one thing, your paper was behaving in suspicious synchrony with Peter."

"That's just a signal to let me know when we succeeded. Anyway, please note that Peter was still going when the bleeper stopped. I only added the inductance of the solenoids as measured by a weak alternating current through their circuits, as data to the programs. When a program was not moving a solenoid, but the inductance changed, it sent me a bleep and tagged the patterns it was receiving. Check the code for yourself." Harold was feeling hurt and self-righteous.

Still skeptical, the two residents ran dumps of the entire code area of the hospital computer, and spent hours scanning the results for funny routines. They learned a lot about what the other labs were doing, but nothing suspicious about the code controlling their time slice. While they were checking his claims, Harold was practicing, desperately trying to accomplish as much as a dog and a not very senior resident could do. He jumped when his bleeper began signaling, but signaling completely out of phase with the operation of his feeder.

Feeling foolish, he switched the pager to voice send/receive, "Robbins here, go ahead with your blasted message . . ."

"Dr. Robbins, we have nothing for you," the voice of Hospcom's chief operator cut in. "Please don't clutter the air. We'll send a bleep when we have something."

"Sorry, sorry," Harold said sheepishly, "some idiot here at the lab was tampering with my pager, and it must be out of whack. I'll come by for a replacement later." Harold planned to bounce the bleeper off the wall a few times before that.

"Scientists," the operator muttered as Harold switched back to

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bleep mode, and got a few quick bleeps that could not possibly relate to his feeder. With some trepidation, he began a careful search of the cages. The Airedale was asleep. The mice were trying to get at each other by gnawing holes in the glass walls of their aquariums cum cages. The rabbit was working its feeder, but not in synchrony with the bleeps. That left Dr. Chun's turtle, whose feeder, now totally emptied, was obligingly opening in perfect time to the paging bleeps. Harold was thoroughly insulted.

Drs. Chun and Hostler came over to find Dr. Robbins contemplating the turtle.

"We've got to admit," Peter said, "that whatever the gimmick is, it's not obvious."

"Now that thing is doing it, too," Harold said without taking his eyes off the turtle. He had put more food in the Feeder, and gradually the turtle's hoard was growing to the tune of bleeps.

"I still say its hogwash," Peter snapped. "Let's try a real test." Experimentally, he worked his feeder mentally a few times. Then he picked up the feeder and moved it several feet away. It would not work for him. "Aha, I was right. You've got some kind of magnet there." He set to work moving surrounding equipment, looking for some sort of actuator.

Harold did not say a word. He was going to scotch the magnet idea for once and for all. First he moved Peter's feeder back to its original position, and nodded to Dr. Hostler to try again. Peter did. It worked. Then Harold put a piece of paper on a lab stand, so that it hung just against the button. Again he nodded. This time both the paper and the button moved. Then he removed the feeder, nodded again, and watched with smug satisfaction as the paper flapped wildly.

Peter and Dr. Chun were finally convinced. At least they were after each had substituted a hand for the feeder and paper, and felt definite pressure. They took the patterns Peter, the turtle, and Toby were using, and set the computer to searching for common features. There were some in the basic motor areas. With these as a base for the computer to do theme and variations on, Dr. Chun and one mouse had gained a telekinetic knack by sunrise. Satisfied with that degree of success, Dr. Chun and Peter decided to allow themselves some sleep, while Harold went home to check on Toby.

Harold brought Toby in to join them as co-worker and co-subject. For the rest of that week they worked with little sleep. The remaining animals were quickly trained. The mass of data grew so large they exceeded their time and data storage allocations on the computer and had to bootleg some from another lab. The additional

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data provided the basis for better training for all. Peter gained sufficient proficiency at applying pressure anywhere at a distance, that Dr. Chun was obliged to work out a telekinetic slap. Despite the strict orders against it, they shanghaied some of the hospital staff into the lab and trained them without letting them know what they were being trained to do. With very few exceptions, all responded to the training, developing their own telekinetic patterns and contributing to the basic pattern which was emerging. By the end of the week they felt they had enough to face Frank Kenny. They had to, for he had sent Harold an ominous message asking him to drop by to discuss the progress of his experiments.

They went to the administrator's office in a group, Dr. Chun, Harold, Peter, and Toby. Harold and Peter carried documents, and Dr. Chun a small bell jar.

Frank was shocked. "I asked you to come Dr. Robbins, not your menagerie. I wanted to discuss a few disturbing reports with you privately, as a friend. Please, Harold, have your people and pet wait outside." Frank wiggled his ears at Toby, who wiggled his right back.

"Take it easy, Frank," Harold said. "We're here to give you a demonstration of the excellent use we've made of the liberties you allowed us. I think you'll be pleased with our progress." Harold put his documents on the desk in front of Frank, and continued with a respectful nod to Hippocrates, "This is an amendment to our last research proposal, requesting permission to redirect the committed funds, the allocation of additional funds and personnel, permission to use human volunteers, including minors, and priority on time-slice and other facility assignments."

Frank was impressed by the pile in front of him. Its mere existence was enough to get Frank off the hook in any future check into such abuses as taking nurses off duty, tampering with Hospcom equipment, and exceeding a computer time allotment. He was glad he had not cracked down as soon as he had smelled trouble.

"You can read that later," Harold continued. "I want you to see some of the results." He motioned Peter to lay his documents, hard copy of the computer data, on the desk. Peter went around the desk as if to help in locating particular pages.

"Harold," Frank complained, "you know it will take me a week just to begin to understand this. Why don't you just give me a verbal sketch?"

"I shall, but I think you'll be able to see the differences between the patterns on pages 117 and 121 and those on pages 235 and 301, as well as between those on 108 and those on 319. Peter, you know the pages I mean. Flip between them in pairs for Mr. Kenny."

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Peter did just that. He leaned over and opened the binder to a page which contained a confusing plot, then flipped to one which contained an almost identical one. Frank tried very hard to see a difference.

"Flip a little faster, please," he asked.

Peter did. When he saw Frank was no longer paying attention to him, but just to the alternating images, he glanced up at Dr. Robbins, got an approving nod, and let his hand go through the motions without actually touching the moving pages. Gradually he increased the distance between his hand and the binder, until he felt sure it was out of Frank's vision. Then he moved back a good five feet from the desk. All the while he maintained the steady alternation of pages.

Harold asked, "See it?"

Frank looked up, puzzled. "Sorry, I just don't see a difference. Those patterns look identical to me."

"That's all right. Try another pair, Peter."

Frank looked back at the waving pages of the binder. No one was touching them, but they were moving. Reacting as if there were a wind in his enclosed office, he slapped down a hand to hold them. Then, realizing how foolish that was, he removed his hand, and watched in fascination as the covers of the binder came up, leaving the document wavering on its spine.

Harold broke his attention. "Those are our real results, Frank. Peter and Dr. Chun are holding that book up." He glanced proudly at his residents. "Put it down you two, before you get a mental hernia." They did, but looked disappointed. Apparently they had been having the telekinetic equivalent of an arm wrestle with the binder as a marker.

"Harold," Frank protested, "you can't submit a proposal on something like this. I've just seen it, and I don't believe it. By the time it's gone through two more levels of summarizing and review, it will look like a prank. No one will approve it, for fear of having to defend his position to the next higher level, even if he is convinced. Just to get him to buck it on up, you'll have to turn handsprings for months. We're going to have to work out a way to support your research until its ready for large scale publicity. It isn't yet, is it?"

"No, there are still too many loose ends. But the revised proposal doesn't say a thing about what we just showed you. At least not obviously. It concentrates on the idea of MEG studies of conditioned reflex mechanisms in motor areas. In part, that is what we've been doing, so it's not completely dishonest. Dr. Chun's bell jar has a piece of very good steak in it. The seal is excellent, so Toby should only become aware of the meat when she puts down the jar and opens it."

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Dr. Chun quickly placed the jar on the floor, and removed the top from the flat base. Toby responded immediately by levitating the meat to a position directly in front of his nose, then sneezing violently.

"Toby conditioned the first part of that reflex himself," Harold remarked. "We're breaking him of it by adding liberal quantities of pepper to stray pieces of meat. That accounts for the second part." Harold had decided he had better break Toby of the reflex after he had discovered the Airedale was being robbed. "Frank, the proposal on your desk commits frauds of omission, but contains enough of the truth to protect our position if, no when, we have a solid theory behind us. Will you stick your neck out, and approve it?"

Frank's expression was grave. "Have your people wait outside a few minutes, please. I want to talk to you alone."

Having done all they could, the residents took Toby with them out to the receptionist's office.

"Harold, I'll O.K. it. We can go to jail together. But I would like to know why you brought in two witnesses. You're quite a ham. Why couldn't you have put on the demonstration yourself? Move a few pencils around my desk, or something? On something this important, I don't think you would try to snow me."

Harold's face showed a mixture of relief at getting the proposal through, and pain. "Because, damn it, what a dog can do, what my two residents can do, what even a turtle can do, I can't."

And he never could. ■

THE ANALYTICAL LABORATORY
JUNE 1969

PLACE	TITLE	AUTHOR	POINTS
1.	Artifact	*J. B. Clarke*	2.60
2.	Dramatic Mission	*Anne McCaffrey*	2.67
3.	The Nitrocellulose Doormat	*Christopher Anvil*	2.70
4.	Jackal's Meal	*Gordon R. Dickson*	3.80
5.	Zozzl	*Jackson Burrows*	3.87
6.	The Ghoul Squad	*Harry Harrison*	5.33

THE EDITOR.

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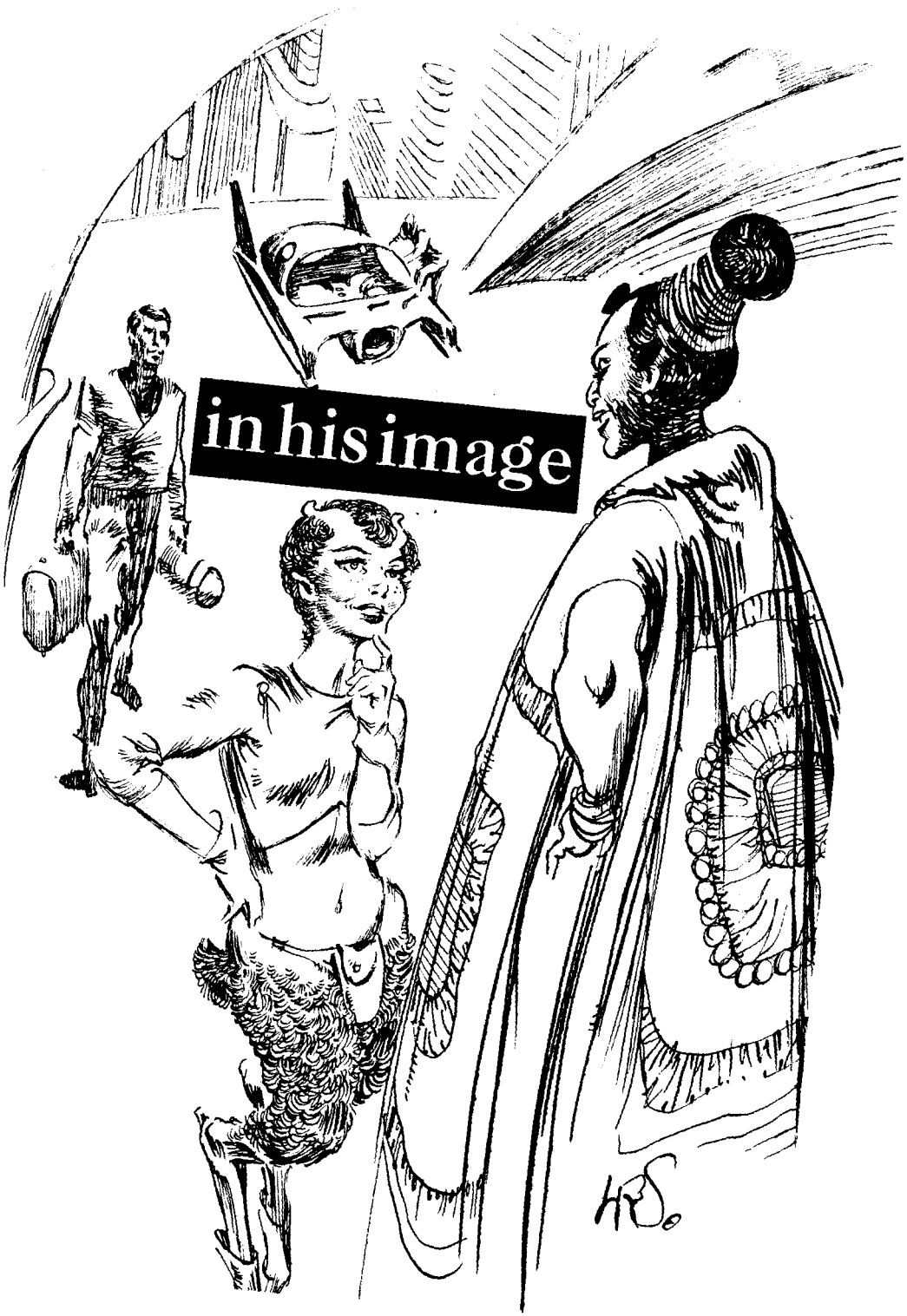

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The way to lead the Public
is to get out in front and convince them they're
chasing you the way you want to go . . .

ROBERT CHILSON
Illustrated by Leo Summers

Ginger danced lightly from one foot to the other, chanting in a whisper, seeming to float. Her red head scarcely seemed to move, while her feet flew. Sugar and Pepper were as excited, still locking horns in front of the mirror and occasionally giggling breathlessly. Even the view of the mountains above Lake Titicaca was forgotten, though this was their first visit to Earth. Mr. Koeppels would be not merely their first reporter, but their first Man. The robot monitor brought them *His* heavy voice as *He* showed Mr. Koeppels in.

"Hurry up, girls," said Ginger, increasing amazingly the speed of her dance. "They're already *here*."

"This is my first visit to Earth since my research entered its last phase, nearly three years ago," came *His* voice. Its perpetual undertone of warm amusement was very apparent. "You can see where all my credit has gone. Though I did use a lot of it in my research."

"It certainly is impressive," said the reporter respectfully. Yuri Koeppels was as impressed as he sounded, though he didn't expect much of a story from this Dr. Birrel, who'd been in retirement on the Moon for seven years or so. Still, the man must've been some scientist, to be able to afford an astromobile home. He said as much.

Dr. Birrel laughed in the quiet, heavy way he had. He was black-haired and black-eyed, fat but not offensively so, light on his feet, and apparently very good-humored. He had obviously not taken geriatrics treatments. He shrugged. "I am more a good engineer, or even inventor, than a scientist. My work has been mostly applying what my betters in pure science have discovered. I get the credit and they get the fame and prestige."

"Still," suggested Yuri shrewdly and hopefully, "all the important men in the biologic sciences will be watching their telefaxes for your

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reports in the journals. They could hardly have forgotten the man who developed substitution catalysis in DNA electrosynthesizers. It would take several pages just to list all the applications of that: geriatrics, mensation, and orthosomatics all use it. And, of course, biomorphics, which is your field, isn't it?"

"In a way, yes. I have done quite a bit of work in the edges of that field, but I am merely a biochemist specializing in DNA, RNA, and proteins—not quite the same thing, though DNA synthesis is the heart of biomorphics."

"Then you haven't actually done much work in controlled mutation?" asked Yuri, controlling his disappointment. That was a big field these days.

"I can't say that I have, not directly," rumbled Dr. Birrel. "The field has never lived up to its early promise. It never will, as a matter of fact."

"I know," said Yuri, who had read up on the subject in preparation for this assignment. "We still lack an elegant solution for the genetic code, a method of predicting mathematically the shape of an organism from its genes. It's still hit or miss, just a cheaper and faster method of mutating than the old radiation experiments in the late Twentieth Century. Not *controlled* mutation. But again," he said with sudden hope, "that's your field, in a way. I mean, you have to study DNA before you can synthesize it. Do *you* have an elegant solution, or at least an approach?"

"I must confess I haven't been able to come up with an *elegant* solution," he said. "Though I do have an approach of sorts." Yuri's face lit up. He reached into his shirt pocket and squeezed his audio recorder on. Dr. Birrel forestalled his eager questions with a lifted hand. "First, let's sit down and have something cool to drink," he said, looking gratefully around the luxurious room. Yuri followed him in impatiently.

"They're in the *lounge,*" whispered Sugar. "Hurry up!"

"Wait a minute!" said Pepper in panic. "Sugar, please—that curl just behind my ear I can't get it right."

"There," said Sugar. "Ready to go? Ginger, your shoes!"

"Right here," said Ginger, patting her pouchbelt. "I'm to dance, remember? I want to be all ready."

"Let's go!" Pepper dropped Sugar's hand and dashed ahead. The others followed, hand in hand, calling in frantic whispers, "Wait, Pepper! Don't go in yet!"

They caught up with her in the conservatory just next to the lounge. All three were breathless with excitement and stage fright, so they huddled into a rose arbor in a big-eyed cluster, arms around each other, cheeks pink.

"As you know," said Dr. Birrel,

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pursing his lips over a tall, insulated tumbler, "the primary problem in attempting to produce that elegant solution is the fact that there are many different gene patterns that will build highly similar somatic structures; for instance, the eyes of men and octopi. In their attempts to solve the problem, the biosynthesists have analyzed thousands of human and animal gene patterns and related them to the somatic structures they define—feathers, fur, tongues, beaks, hearts, and so on. But they have still not discovered the mathematical relationship between gene and structure.

"The biomorphists' empirical approach, which makes use of the known genes, is becoming ineffective, too. Double-hearted animals are commonplace, but real improvements in plants and animals come slower, because they are more subtle—disease resistance, nitrogen-fixation for plants, better fruits and vegetables, and so on."

Yuri got that. "But you say you have a practical approach that promises success?"

"That is right. But perhaps it would be simpler to show you the results of the approach, then explain it to you."

"Fine!" said Yuri heartily, coming to his feet. He hoped—it began to seem—that this would be something really good, a real breakthrough. That would be very good for his career, too—Pan Solar was the only news service that had sent a reporter to interview Dr. Birrel on his latest research. But he made no move.

Pepper, springing lithely to her feet, almost fell. Hearts pounding, taking short steps and frequently bumping each other, the sisters crowded up to the door, thumbed it open, and spilled into the lounge. Pepper was still in the lead.

They stopped in a tight cluster, Sugar and Ginger looking over her shoulders. After a reassuring glance at *Him*, they focused their attention on Yuri Koeppels. They saw a tall, rather broadshouldered, though slender young man with wavy brown hair. His face was smooth and rather stubby, as if he were still in his teens, but he was good-looking enough for all that.

Yuri's interest had perked at first sight of the girls. His second glance had caused him to redden slightly with surprise, as the girls were bare from the waist up; he had hardly expected that in the lounge of a man conservative enough to ignore geriatrics treatments. Resolutely not staring, he looked at their faces, which were highly similar. The girls were small, slender, about five-five, apparently in the middle or late teens; each wore tight, furry pants the color of her curly hair: black, red-gold, platinum blond.

Then the girls focused their attention on him. Their pointed ears swept forward an inch or so, stark-

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ly outlined against their hair. His smile froze and his jaw dropped. The ears drew his attention to the horns sprouting from above and a little behind them; short, curving toward each other over the top of the head. There was room between and under them to put a hand or comb, but they were quite small and close. He had thought they were merely fancy hats. Each girl's horns were nearly the color of her hair: a kind of translucent ebony, pearl gray, translucent redwood.

Wide-eyed, Yuri's gaze traveled down their figures to their feet, which turned out to be hooves, tiny things, split, the color of the horns. The ankles were deliciously slender; it seemed impossible for them to balance themselves. Then he looked again at the pants and was only mildly surprised to discover that they were actually fur, not pants at all. The girls were bare but for pouchbelts.

Of course, he thought numbly. *No pockets!*

Dr. Birrel was chuckling heavily, voice like warm oil. "Well, Mr. Koeppels, you seem entranced by my daughters. I am sure they appreciate that unconscious compliment, and I believe they reciprocate, judging by their expressions."

The sisters pinkened, spread out more. Yuri managed to stammer something, pulling his jaw up. The three had the same face, barring slight differences in complexion and freckles—the redhead had a delightful crop of freckles across her nose. The brunette paced forward on her tiny hooves, like a girl in very high spring heels; only she moved with a lithe grace, as if the springs were built into her legs. She looked up into his wide-open face, grin widening. "I'm Pepper, and you're all right."

The other girls crowded up with the same high, mincing steps and introduced themselves, the ice broken. Yuri found one almost too much; three definitely so. While he tried to say hello to each one and introduce himself to them all at once, Pepper stepped forward and poked at his stomach with a stiffened forefinger. He tightened his diaphragm by reflex and she nodded in pleased approval. Ginger spread her hands to measure his shoulders, head on one side, eyes sparkling. They were green, he noted; Pepper's black; Sugar's, pale blue. Sugar brushed back a lock of his hair over his ear.

Feeling a little weak in the knees, Yuri tumbled back into the lounger he did not remember having left. Dr. Birrel's chuckle had become genuine laughter; his great bulk heaving, he said, "Enough, girls. Let him get his breath."

The girls were a little pinker, but still bright-eyed. Pepper, overcome with sudden bashfulness, trotted over to *His* lounger and straddled the arm. Ginger went a little way out in front of Yuri's lounger and sat cross-legged on the floor. He

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noticed dazedly that they had short tails covered with that soft fur, that worked back-and-forth with each step. These were short enough not to get in their way when they sat down, yet long enough for them to switch delightfully when in the mood, as Pepper was.

Sugar, though a little abashed by her own boldness, did not retreat. She climbed up on Yuri's lounger arm, hooves almost under her, knees almost in his lap. He stared at the soft, almost white fur that covered them. It was silk-fine, with a little curl at the end; if it had been longer it would have been wavy. Her hair was even more curly; like all the girls', it was a cloud of ringlets all over her head and spilling down on her neck.

"Surely this can't be biomorphics, sir," he gasped at last. "Not in one jump! Plastic surgery?"

"That is your first coherent sentence, young man; perhaps it will be recorded in history. You're quite right," *He* said, sobering but still with a current of amusement in *His* voice. "They are synthetics. Androids."

There was a little silence while Yuri stared again. "Really?" he whispered, looking at the sisters in turn. "But how'd you ever do it? Why, Von Brauchitch claims that advanced animal life won't be synthesized in this century. Some researchers say that intelligent life is so complex we'll never be able to duplicate it."

"We know," Ginger told him. "We read all such reports and interviews. They're a storm." Yuri had to grin; under the circumstances, they must be.

Dr. Birrel smiled fondly at her. "The process is adapted from biomorphics, but the result is equal to anything biosynthesis promises. General-human DNA of the sort used in orthosomatics is the starting point. As you know, such DNA chains contain the entire gene print for a human being except for the personal characteristics: hair color, complexion, shape of face, et cetera. The Rodman effect, which makes possible the duplication of molecules without knowing their structures, is not perfect; on such complex molecules, the fine details are lost. The process itself is something like biomorphics, since it involves the synthesis of transformation DNA and the mutation of the genetic pattern with it; but the transformation is done outside the cell, and the desired transformations are carried out, one at a time, on the same DNA chain. That is, after every half-dozen or so transformations; and since there is only one work-piece, there is no need to crossbreed to fix genes until the final form is reached."

"I think I see," said Yuri, eyes lighting with excitement. "Your transformation DNA is, say, a copy of the gene that builds horns in certain kinds of goats; it is brought

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against the work-piece, where it attaches itself to the genes that define the head. Next you reshape the feet into hooves, displacing the old genes; and so on until you have the complete pattern for your android. After that you synthesize a cell around the new nucleus."

"For us, the term is capriform android," Ginger told him.

"It may not be genuine biosynthesis, but it beats what they call controlled mutation," said Sugar. "Imagine trying to produce *us* by any such inefficient methods!"

"Or anything, human or animal, half so attractive," grinned Ginger.

"He notices that," Pepper told her, cocking her ears and an eyebrow at Yuri.

Yuri reddened, then still more as Sugar patted him on the head, saying, "Don't, Ginger, Pepper; he was nice to you." He had such a bewildered and hunted look that Sugar felt a surge of warm sympathy; she wanted to cuddle him to her and soothe him. It was what *He* called mother-love, and it hit you all-of-a-sudden, and it always felt wonderful, but it was always disconcerting.

"I can have them put on blouses if you wish," *He* chuckled.

Yuri reddened again. "Oh no, this is all right. Uh, you called them capriform androids," not looking at Ginger. "That means goat-shaped, doesn't it? Why this particular shape, Dr. Birrel? In fact, why androids at all? You know a lot of people are going to scream about that. They have religious, or philosophical, or moral scruples against synthetic life in general and androids in particular. You know the kind I mean. It might have been better to start with animals."

The girls were obviously amused at the thought of that kind of people. "Religion, philosophy, or morals; whatever they call it, the true name is fear," Dr. Birrel declared. "They're afraid they'll be replaced by some strange life form, some monster. It's a foolish fear; anything made by men is going to be acceptable to Man. But no really significant improvements can be made in plants and animals except by accident until we have that elegant solution. Human beings, on the other hand, are adaptable enough so that a slight improvement becomes highly significant. The girls' purpose is to break down the public's resistance to the idea of such improved human races. I look forward to a species-pluralistic society, containing mermen, say, and men capable of adapting to extremes in atmospheric pressure; desert dwellers; cold-climate dwellers with fur; high-gravity men, and so on. Such a society would be far more interesting than this one; and we'll need a multiplicity of subspecies when we reach the stars. In fact, we'll breed them normally if we don't synthesize them."

"Well, why this particular shape? Not that I'm objecting," glancing

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quickly at Sugar, who smiled sweetly. "But why not a normal human shape to break the ice?"

"Because we're specially designed for entertaining," said Ginger, rolling to her feet in one smooth motion. She clicked across the floor to a round, six-foot stage, raised a hand's-width above the floor. It was wood, damped to kill resonance. The sound of her hooves on the floor made Yuri peer closely at her feet, then glance at Sugar's and Pepper's, both of whom moved as silently as ghosts.

Sugar laid one ankle on the other knee, extending her tiny hoof toward him. Each half of it was covered with a crescent of soft rubber, held on with stasite, the stuff used on nail masks. "We're genuine hoofers," said Sugar, clicking her toes together and smiling at Ginger, who erupted rather like an ancient machine gun.

In a human being it might have been called a tap dance, but the more he saw of it, the more Yuri doubted that any human could have done it. The girls were almost fantastically lithe. You might almost expect them to walk around in a perpetual crouch, though they stood as straight as so many elm trees.

"Now you know why we're called capriforms; we not only look like goats, we jump like goats," laughed Pepper, landing beside Yuri's lounger. She bounded straight into the air, did a complete flip, landing in her tracks, and instantly lifted off, almost floating, in a back flip. Keeping perfect time, Sugar noticed approvingly, with Ginger's twinkling hooves, purely out of habit. *He* had trained them well.

"At least we don't smell like goats," she smiled at Yuri. "Now what do you think all those lovely people who oppose biosynthesis will think of us?"

"Can you do more conventional dances?" Yuri asked her.

"Sure," said Pepper, landing on her feet and instantly trotting forward, spinning on one hoof, dancing lightly aside, spinning again, trotting forward springily—a perfect Enzer, switching her tail deliciously with every step. "But it's too slow," she said. "If the dance is not at least as fast as the Osage Drum Dance, it's no fun." She peeled off her shoes—a quick squeeze on the piezoelectric crystal to reverse the stasis field; they came off more easily than nail masks—and tucked them into her belt, then joined Ginger on the stage.

They went into the two-hand section of the Drum Dance, legs a black-and-red blur, whirling around dizzingly. "It's the double-heart system that gives us the stamina," Sugar told him.

It ended abruptly and Ginger did two flips that placed her just in front of his lounger. Her hooves almost went out from under her on

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the slippery floor and she had to clutch his knees to keep her balance. Pepper followed more slowly.

"How about it?" asked Ginger.

"Think you can get us an audition of some kind?" asked Sugar.

They watched him breathlessly as he turned to *Him,* who had remained fondly silent.

"Do you intend to let them dance? I mean, to get a job as entertainers?"

"Of course," *He* said. "They cannot spend the rest of their lives in laboratories. They have been trained as dancers and can sing. The whole point of creating such charming and appealing androids is to break down the public's resistance to the idea; to do so, they must go where they will be seen. And you needn't worry about them having to entertain in low cabarets; they'll soon be audio-visual stars. Not that they can act convincingly; they're too young."

A look of sudden enlightenment broke over Yuri's face, making every girl giggle. "Just how old *are* you all?" he asked, looking at them with new eyes.

"Six months," they chorused, laughing.

"They were synthesized three years ago," *He* said. "But they only came out of the incubators six months ago, already physically adolescent. Of course, mentally they were as blank as any baby; they had to go through the crawling and toddling stages, but having fully-developed brains and bodies, they went through them very rapidly."

"It took me three days to learn how to sit down in a chair," said Sugar reminiscently. "I would just climb up into it on my knees and then turn around."

Yuri thought for a moment. Pan Solar News, of course, also made documentary audio-visuals for sale to the magazines, and occasionally sold them direct to the public by TV. Granted sufficient publicity in the newspapers, plenty of people would pay to see these entrancing girls in an hour-long show. Androids alone were one of the great news events of the century. After even one such show, the A/V record companies would get in touch with them. Every telefax and TV in the System should soon be carrying the girls.

"All that's necessary," Yuri said, nodding, "is to have them dance on a documentary. They'll be calling you then."

"My idea exactly," beamed Dr. Birrel as the delighted girls dug into their pouches.

"Show these to your boss if you have trouble convincing him," Pepper said, producing a fistful of records.

Pan Solar kept the news of the androids as close as it could until it had tucked the amused Dr. Birrel's astromobile home in an exclusive park in Idaho's Bitterroot Mountains, convenient to its summer stu-

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dios on the Snake; interviewed them to exhaustion; and recorded the first documentary. Yuri was unofficially appointed PSN's liaison man to them since he was known to them and was the corporation's expert on the androids. He suspected that part of his job was to persuade the girls to hold still for the storm. That was unnecessary; they took everything with the delight of kittens.

For the interview and dance part of the documentaries they called in PSN's own personality, Jeff Jackson. Jackson drafted Yuri to help with the shows, though he did not appear in the records. The girls refused to memorize any kind of script, and all they could do was find out, in general, what their answers to a given question was likely to be. Yuri was very helpful here; he had interviewed the girls several times himself, and had sat through dozens of others during which the sob sisters pitied the poor dears for never having had a mother. They had no objection to blouses, except that they were hot while dancing, but Yuri told Jackson not to bother trying to get them to wear bras. That obviously bothered him, as it was supposed to be a family show and the girls' dancing was on the vigorous side. Fortunately they had the dancer's classic figure, slender and small-breasted.

"But are you really human beings?" Jackson asked them.

Pepper said, "Depends on what you mean by human. *He* calls us Homo Capriformus, meaning we're the same genus but a different species, like lions and tigers."

"That's right," said Sugar. "I guess we have human rights. That's kind of too bad, isn't it? We'd make such wonderful pets."

"That's what people have babies for, Sugar," Ginger told her. "You needn't feel sorry for them."

"Uh," said Jackson, recovering, "I gather that you're not able to have babies yourselves. Do you ever wish you could?"

"Why?" asked Pepper pleasantly. "Then we'd have to wait until *He* or someone synthesized capriform husbands for us. Now we can marry anybody we like, since we can't have children anyway."

"Or we could have 'em synthesized; that way we could have children without having to put up with babies," said Ginger.

"Besides, fertile women have blue periods and have to take pills, and so on. What baby is worth all that trouble?" Pepper asked, wide-eyed.

"Unless it was a *boy* baby," Sugar suggested, propping chin on fist, elbow on knee, and glancing at him sideways.

"Are you married?" Ginger asked interestedly.

Jackson took it very well, passing it off with a laugh. "I understand that Dr. Birrel did not want to create another race of human beings, at least not without the per-

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mission of the rest of us, so he left you sterile. It is possible, isn't it, to make capriform androids that are fertile? Why not have two races? My daughters would be delighted to meet your brothers, if you had any."

"It's because we're not good for anything," Pepper told him. He couldn't help blinking, to Yuri's secret satisfaction, remembering his own first interview with them. "We're just good for dancing and looking at. Now if we were mermaids, or if we could live in space without vac armor, *He*'d have no objection."

"Or if we could live on Jupiter, or Venus," added Sugar.

"Actually, we capriforms are just here to sell the public on androids. Not many of us are needed for that," said Ginger. "But *He* miscalculated, for once," shaking her head. "It won't work." She gave the icon a sultry look. "It loses too much in transmission."

After that, their dance came as a relief to Jackson.

By the time the first documentary was broadcast, the news of the androids was all over the System. The public's reaction was mixed; in general they were hostile to the idea of androids, but those who saw and heard the girls were captivated. They were not in favor of peopling the System with monsters, but could not resist the girls' appeal.

Yuri passed along to Pan Solar Dr. Birrel's famous remark that new races of men would have to be acceptable to Man, and a number of articles were written around it. The girls, they pointed out, had perfectly normal human brains. But the public buys new ideas very cautiously. Give 'em a couple of years to get used to the girls, thought Yuri. The glamour of their stardom would rub off on future androids. Dr. Birrel had described for reporters his ideas for a race of mermen, which seemed to interest the public. But the girls were still their best selling point.

The girls, whom he saw daily, were in seventh heaven. Having spent all their short lives secluded on the Moon, he'd have thought they'd be too shy to speak, assaulted by a crowd of reporters and agents. He should have known their reaction, remembering how they had greeted him. Pan Solar's precautions had paid off; most of the curious were stopped by Cheviot Preserve's ever-vigilant directors. Only those in the upper social levels were passed. It did not seem to occur to the girls to protect themselves. He never heard of them refusing to be interviewed.

The second TV interview was like the first, half of a documentary; once it was recorded, Jackson was finished, as the third would be done by Maxine Bibot.

The girls were in the conserva-

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tory, their favorite room, when Yuri came in one morning, their third week on Earth. Pepper saw him first and was flying toward him before Ginger could look around. She saw him grin that little-boy grin they never got enough of and brace himself to receive her, but, of course, she knew better than to jump at anybody, even as tall and strong as Yuri, at top speed. She braked, leaning back and digging her rubber-shod hooves in, then bounded lightly forward, landing right beside him, motionless. Instantly she leaped straight up, tucking her legs under her and throwing her arms around his neck, or, rather, shoulders. He slipped one arm under her and took the weight easily.

Ginger was swinging from his other arm before she had time to speak to him. She was carried across to Ginger's lounger, switching her tail demurely, and deposited on the arm. Ginger promptly perched on his lap. He was pleased, she could tell, but a little red-faced.

"Yuri, this is Mr. Frolich of Galactic Records. He wants us to make a record—a ninety-minute fiction piece!" she said breathlessly.

He grinned, looking over at the agent. "Did you figure on signing them to do a record, or to something like an exclusive ten-year contract?"

Mr. Frolich grinned back. He looked a little like a freckled frog, but he was nice; very friendly. "I asked around, the last couple of days, and found that everybody that waved exclusive contracts at them was told 'don't call us.' They never even got to dicker; the first offer was all the girls would listen to."

Yuri looked at her, then Ginger. "Mary had a little wolf, she fleeced him white as snow," he grinned. "Where's Sugar?"

"Taking a shower," said Ginger, turning and leaning against the other arm of the lounger. "She did a demonstration for Mr. Frolich."

"I'm tempted," mused Frolich, "to quit my job and join the girls as manager. They'll need someone, quite a few someones, in fact, since they'll have little time left after recording, studying, and practice to consider investments, read contracts, and the rest. I don't suppose you'll be willing, let alone able, to handle business for them," he said to *Him*.

He shook his head smilingly, looking at his glass. "It would be a strange sort of retirement—from biochemical research to business. No, they're launched, as far as I'm concerned—I'm just the designer."

"It's sort of odd that they'd know so much about contracts and so on, but hardly have heard of Cal Varril."

"They've been studying for records since they learned to talk," *He* said. "But six months—almost seven, now—is not a very long time. They've viewed a selection of

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record classics back to Shakespeare, but study time had to be used for the basics, including law and business. They were born knowing English—structured RNA—and that saved a lot of trouble. Most of the time was spent in dancing, of course."

Pepper winked at him, remembering. Learning to speak—she was still learning, of course—had been breathtaking. You'd hear a new word, and suddenly you knew it, like it was an old one. But you could never think of it until you heard it or read it.

"Here's Sugar now," said Ginger, looking past Yuri. She was toweling herself vigorously, hair and fur damp. Wriggling quickly into her blouse, which she had left on a pink dogwood, she put on her belt and came around Yuri's lounger, peering at him.

"Hi, Yuri. You sleep late or something? You should've been here an hour ago—I was dancing."

Pepper felt Sugar's hands on her shoulders, but before she realized her intentions, she had been flipped backward off the lounger's arm. She twisted her feet aside in time to keep from kicking either Ginger or Yuri in the face. Then she caught herself on her hands, pushed, and was on her feet. Sugar had had time, though, to ensconce herself on the lounger, her arm around Yuri's neck and her small nose against his cheek.

"You're going to have to learn to get up earlier," she murmured, looking at Pepper out of the corner of her eye.

Pepper couldn't help laughing. She climbed up on the arm beside Sugar, seized her by one horn, and yanked her away from Yuri. "Arrant wench!" Sugar scooted over, laughing, and they put their arms around each other in a sudden mutual flood of sisterly love.

News of their contract with Galactic made the front page of newspapers all over the System; Maxine Bibot questioned them about it on her TV interview. However, if record viewers were delighted, record makers in general were not. That week, as they answered questions, danced for the public on two TV variety shows, and studied and practiced almost constantly, the murmuring in the entertainment industry grew. Galactic sent them no word, being busy, according to the papers, with internal troubles. A number of other companies had made them attractive offers once they realized that exclusive contracts were *non grata* in Cheviot Preserve. They had not accepted any of them yet, and toward the end of the week, with public opinion against them mounting, some were withdrawn; and few new offers were being made.

It seemed that as nine-day wonders they were acceptable; as flesh-and-blood robots, the stuff of millions of daydreams, and as symbols

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of the utility of biosynthesis, but not as human girls—not where they competed with ordinary men and women for jobs. They personally threatened only the people in the entertainment industry, but the public realized that they were just the point of the knife. General Oceanics, polling the public on the subject of mermen, found it ranging from negative to hostile.

On Friday their troubles came to a head; the Actors' Guild filed suit against Galactic Records, obtaining an injunction. They said that androids were "created beings, hence akin to robots"; robotic puppets were restricted in their contracts with the industry. The legalisms were immaterial; their primary weapon was the public's fear of being replaced. The suit gave all suppressed fears full expression.

Galactic would not dare press the battle in the face of public hostility. Since Weldon West's invention of the gravitronic motor and the development of all the other applications of gravitronics, society had liquefied. The sheer impossibility of collecting taxes, when the disaffected can slap together a makeshift astromobile and go off to the asteroids, spelled the doom of bureaucracy. It was up to the judges, then, to maintain some degree of justice and judges who permitted outmoded laws to obstruct justice had frequently been lynched. Since the general abandonment of the cities, the selection of judges had been brought closer to the voters. An unfortunate result was that the judges tended to play to the crowd. The people got what they wanted—not justice.

The girls' lessons in history had been comprehensive; they saw all the ramifications clearly enough, and sank into gloom. They were pacing around in the lounge, heaving sighs at regular intervals, when the monitor chimed and announced Mr. Frolich, formerly of Galactic Records. They had instructed it to turn everyone away without disturbing them, but Mr. Frolich was on the short list.

Entering the lounge a little later that day, Yuri opened the door on pandemonium. Sugar was staggering across the knee-high, transpex-topped table; Pepper doing a handstand beyond it; and Ginger leaping for it at full speed. As Ginger landed on the table top, she doubled her legs under her, then uncoiled like a released spring, gleaming red horns reaching for Sugar's slender waist. Sugar had had time to recover her balance. She avoided the horns lithely, laughing, and caught her sister by the shoulder, trying to push her to one side and off in mid-leap. But Ginger grabbed her arm and yanked as she staggered sideways. For a moment they teetered on the edge, each trying to throw the other off. Then Pepper landed in the middle of the table top, legs doubled under her.

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She uncoiled in the girls' devastating fashion and stiff-armed the others off. One of them managed to catch her arm and drag her with them. Pepper teetered precariously on the edge herself, as the others landed in a breathlessly laughing heap, then her hooves slipped off and she sat down heavily on the edge of the table. She had scrambled, laughing, partway back on, before the others got to their feet. They grabbed her arm and leg and jerked her off.

"Yuri!" she cried, as she landed on the floor. The other two saw him then, and he was inundated by them, all talking at once. Before he could do more than say hello, they had told him that Mr. Frolich had become their manager, that he had a plan, and that he wanted to see him. They dragged him into the conservatory, where Frolich had been talking quietly to Dr. Birrel, sat him down in a lounger, brought him drinks, and swarmed into his lap. It was like having a lapful of kittens.

"You wanted to see me—I believe?" he said, looking at the girls doubtfully.

"That's right," said Frolich, laughing. "The girls tell me you've been down to Silver City. You understand what the girls' chances of happiness are, then."

Yuri nodded. "Ten years or more from now, some new android will try again and open the doors, but this is the girls' only chance," he said somberly. "They'll have been forgotten by then except for historical background in the articles."

"That's the idea. The Guild is swinging the public against us. It's like they're herding sheep; they mean us no harm, they're just protecting their own interests, but . . ."

Yuri nodded again. "You said something about a plan."

"Yes. As I see it, the thing to do is to lead the sheep in a circle, back over the shepherds."

"It *sounds* great," said Yuri dubiously. "How do you do it?"

"Well, what direction are they going? At this rate, they'll soon have made it a matter of legal precedent that an android, or other 'created being', is legally property, like a robot. The precedent will hold until some judge decides to upset it, but that won't happen until a clear majority of the public change their minds. So we take a step further in the same direction. We sell one of the girls."

The girls all grinned at him, undismayed by the prospect. He pulled his jaw up, and managed to croak, "There must be more to it. Out with it."

"Your reaction is, as the pollsters say, negative, yes?"

"Yes, of course!"

"Most people will agree with you, I think. Men might secretly like to be able to buy girls, but few would care to have women able to buy exotic men. Women, in particular, will find android ownership

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decidedly indecent. Especially the Discussion Clubs." He grinned, frog-like. "Lucky they had that clause limiting use of robotic puppets; the temptation to use it against the girls was too great."

"You make it sound too simple," said Yuri, dismayed at the thought of one of the girls sold to some drooling vacbrain. "Forbidding ownership of androids is one thing, but granting them freedom to compete with men is another." He shook his head, looked over at Dr. Birrel, who also looked unhappy. "What do you think of it?" he asked.

The other frowned. "I don't like it any better than you do. But I admit that I'm out of my element here. Mr. Frolich does seem to understand the public."

Yuri felt abandoned, yet he couldn't voice his objections—not with the delighted girls reading his every thought from six inches away.

"So, which one would you prefer?"

"What?"

The girls exploded into laughter at his expression, Sugar leaning out to protest something to Frolich. Pepper gave him a delighted hug, and Ginger said, "Was that reaction negative or positive?"

"But—I couldn't—I couldn't begin to . . ." he began dazedly.

"Remember, this is merely for the benefit of the news services."

"But—"

"You're not hinting that there's something wrong with *us,* are you?" asked Pepper, peering into his eyes.

"Let me think," he said feebly. To Frolich, "The idea is to arouse the indignation of the public?"

"That's right. Also, the mere idea that anyone, even an ordinary young reporter, can afford to buy an android, will give everyone the horrors. Think what it would do to society. Free androids, and the problem of fitting them into society, is a mild problem beside that."

"But our main purpose is to arouse indignation. I'll be the monster in the scene, the girls the innocents. I see your plan," he nodded. "Yes, I can buy it. But I still don't like it," trying to avoid the girls' eyes. *Better me than some men I know,* he thought.

Sugar had climbed down and brought a spinner and card from some child's game. "High score wins," she said, and before Yuri could grasp her meaning, they had all spun it.

Sugar won. Yuri looked down on a radiant face between two of the saddest ones he'd ever seen. Ginger and Pepper were blinking back tears, lips quivering; they looked for all the world like two puppies left outside at night for the first time. He reached down and gave them both a bear hug, and Sugar hugged them from the other side. They were nothing if not game; in a few minutes all were smiling.

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"Next time *I'll* get the spinner," said Pepper huskily. Then they both hugged Sugar. Ginger said, "We'll help you pack. Come on, let's hurry!" Sugar had time only to squeeze Yuri's hands, then they were gone.

An hour later Yuri, still dazed, was airborne with a chattering platinum-blond android all his very own—it says here. Specifically, it—the bill of sale—said that he had, "for considerations received and forthcoming" purchased forty-seven kilograms of assorted organic compounds "formed into a living experimental animal, description below"—Sugar's name not being mentioned anywhere on the document.

"The Actors' Guild has compared them to robots, which are nothing but zerohmic crystals," said Frolich. "By that reasoning, an android is 'nothing but' a mass of organic compounds; an experimental animal, at best."

Frolich called the panting reporters together, and in comment on the Actors' Guild suit, announced that they had "accepted the decision of the public"; they had sold Sugar and options on her sisters. The new owner proposed to exhibit them on the live circuit; Dr. Birrel would receive twenty percent of the net for the next ten years. He had retired, and had no plans for producing more androids.

By the time Yuri and Sugar got to Cleveland, a flight of over an hour and a half, two-thirds of the population of the Inner Planets must have known about the sale. Frolich had not disclosed the name of the purchaser, but Yuri could not long remain anonymous even if he wished. His apartment was in the Spire of Cleveland.

Cleveland had not gone the Free City route during the dissolution of society. The city's Negroes had long been restricted to Hough House, the world's largest building; when the upper and middle classes bought air- and astromobile homes and flew away, the lower-class Whites were unable to cooperate with the Negroes on the city's administration. Things were violent in the Jungle, the abandoned residential districts, for a time, but when things began to stabilize to the point where secession might have been possible, it was no longer needed; the new world was born and growing lustily.

As in most cities, the white-elephant office buildings, such as the hundred-story Spire, had been converted to apartments. They were occupied by people late of the Jungle and Hough House, mostly young, on the way up. It was just this group which could be expected to be most hostile to androids; the group with which they'd compete for jobs.

The hangar on the eighty-ninth level opened for them automatically and Yuri swept into the landing

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cradle of his parking tower. Sugar, quivering with excitement all the way from Idaho, bounced out and took in the drab hangar with delight. The usual complement of loafers went slack-jawed. At least she was dressed. Yuri struggled out with her two suitcases—the larger one, he had learned, contained mostly toys and games.

Her smile widened impishly at one oldster's remark, "I never knew they were real—I thought they just had 'em on TV," but she said nothing. Luckily the locals were too awed to approach; they were able to get through without having to answer half a million questions. Yuri would have slunk hastily through if he could, but Sugar took her time.

A stunning Negro girl with the air of a queen entered the hangar just as he was leading Sugar out, relieved. Sugar took her in with one wide-eyed, awed look and bounded forward, arms extended, saying, "I'm Sugar and you're beautiful!"

The girl—Yuri finally recognized her as one of the youngsters who just yesterday had been sitting on the parking towers, wistfully watching their older sisters come and go with their dates—bent over her with a sunrise smile. "I've seen you on TV," she said, voice as rich as that of a trained actress. *"You're* the one who's beautiful."

"And this is Yuri," added Sugar. "Aren't I lucky?"

She smiled politely at Yuri, who was tongue-tied by her sudden magnificence and his own inability to remember her name.

"He just bought me," Sugar explained eagerly.

The smile vanished. *"Bought* you?" she asked wonderingly, looking at Yuri. He managed a sheepish grin, made the mistake of looking at Sugar, wished the suitcases were in orbit.

Sugar explained about the Actors' Guild suit and Dr. Birrel's "decision." She leaned her head against Yuri's chest, face radiant. *"I* was the lucky one. And Yuri was lucky, too, of course. Isn't he nice?"

The girl gave him an icy look that loosened his jaw. "Yes, nice. And very, very lucky." The smile flashed back on as she bent over Sugar, squeezing her hand. "I hope you'll be very happy," she said, as if to a child.

"Oh, I am!"

The girl nodded sadly once, flashed Yuri another look, and brushed past.

"Did I do that right?" asked Sugar innocently as they went up the hall.

Yuri caught his breath, said, "Perfectly."

She smiled as at some secret, glanced wonderingly up at him, and said, "But you didn't say anything. Aren't you supposed to be acting, too?"

"Don't worry, Twink, I did my part," he said grimly. Sugar started

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giggling and couldn't stop. "You little imp!" he exclaimed. "I should've bought a whip first thing."

Yuri had a four-room apartment, seeming very small after Dr. Birrel's palatial astromobile, but Sugar did not seem to notice the contrast. She followed him around, taking in everything. He had thought of putting her in his bed, but concluded that she could stand the couch better than he could. The smaller suitcase contained mostly blouses; no need to unpack them. Sugar took out the curry-combs, hairbrushes, and the meager cosmetics kit, and carefully arranged them on Yuri's dresser. Yuri was somehow not surprised to find that the symbol on them was that of a female satan with a fantastic figure. The other suitcase they didn't bother to open.

Yuri had recovered somewhat by the time he'd finished dinner. Though he did not exactly look forward with joy to meeting his neighbors—the tale was undoubtedly over the building by now—he'd have to face them. Sugar changed blouses twice and spent ten minutes brushing and rearranging her curls, moving at a dance, while Yuri's jitters grew. She didn't look any different to him, but when they stepped into the rec-room, she was stunning. A concerted sigh, or maybe gasp, arose, and Yuri swelled a little with pride. The rec-rooms, one on each level, were set up for the younger children. The older folks on the eighty-ninth floor had gotten into the habit of gathering in it every night. Tonight there was an unusual number of young people and children.

Sugar began by hugging a wide-eyed girl-child who came to a fearless stop right in front of her and stared, then hugged the girl's embarrassed mother. With Yuri following in her wake, she proceeded to make the circuit of the room, speaking to everyone, examining each as boldly as a puppy. In ten minutes flat, she was the most popular person in the entire building. Sugar was soon separated from Yuri, surrounded by a crowd of women, young and old.

"It must be something to be able to remember how it feels to be born," mused an old woman, looking at her curiously. "Is it like they say, like waking up?"

Sugar tilted back on her hooves, studying her. She had not seen many old people. To think that she herself would someday have had as many experiences gave her a strange feeling. "Not really," she answered musingly. "When you wake up, you're sometimes confused at first, but you know who you are, and what you are, you know all about beds and rooms and doors and waking up in the morning You know that you have a body and you can tell where it is, and you know the difference be-

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tween it and the rest of the world."

"You mean, a baby can't even tell the difference between itself and the things around it?" asked a young woman incredulously.

"Not really," said Sugar. "Not at first. But they learn all those things before they start really thinking. Then they forget all about what it was like when they learn to talk."

"You girls were born able to speak and read, weren't you?" asked another. "That must be very convenient."

Sugar smiled. "In a way, yes. But if you've ever taken structured memory-RNA, you'll know it's not that simple. We were born understanding English and phonetic script, but that's not the same thing as being able to speak and read. We're still learning that."

"Can you remember what it was like before you were born?" asked the old woman.

"I can still remember a little of what it was like," Sugar told her. "A sort of floating, dark nothing; very peaceful. Being dead must be like that. For a long time I was afraid of the world, and kept wanting to go back to sleep. Then I got to be afraid of sleeping, for fear I wouldn't wake up again. It was only yesterday, but it seems so long ago."

"Only seven months," breathed one of the younger women; she was dressed in a beautiful gown that made Sugar envious. Yuri had said that probably a lot of them would stay home tonight on the chance of seeing her. In fact, there seemed to be people here from a number of floors; the room was crowded.

"How long did it take you to learn to walk?" asked the old woman, struck by the thought.

"Only about a week. The incubator had an exerciser complex, you know, and that opened the nerve channels. It was also important to the muscles, of course, but the nerves are the main thing. We were starting dancing and singing at the end of the second week."

Faces lit up at the mention of dancing. "Give us a demonstration!" she was urged. Nothing loath, Sugar grinned, looked around for room, tugged at her blouse. The mere thought of dancing made it feel like a winding sheet.

"Not unless you're a lot richer than I am," Yuri was disappointing his listeners. "They only let me have her on credit. I can make enough renting her as a dancer on the live circuit to pay for her and to live on, a lot more than I'm getting now. Naturally Dr. Birrel didn't want to go into the business. He's retired, you know."

"But when they go to making 'em by the thousand, that'll put you out of business, won't it?" asked one young man in formal evening dress.

"Well, not out of business," Yuri

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said. watching Sugar's twinkling hooves. "I'll have considerable mass by then. I could buy up a lot and promote them—they will be a lot cheaper. But you're right; I'll have to get the credit while I can; androids will be common soon. In fact, I think it's only a matter of time before every record company in the entertainment industry is producing its own special androids, and all kinds of other animals, too."

"Don't bet on it," said one old man in the background. The crowd of eager young men turned to look at him. He was sucking a reeking black pipe, had several days' growth of beard, and should have been sitting on a bench in front of a general store a century and a half ago. His voice was dry, sour, pessimistic with a lifetime's knowledge of human beings. "They'll change the law fast enough," he said dryly. "I don't mean they won't make more. But they won't be bought and sold."

"Why not? You don't call 'em *human,* do you?" asked one loudly-dressed youth incredulously. Yuri had a brief daydream in which legions of loudly-dressed youths died in agony.

"Got nothin' to do with it," grunted the oldster. "If you were married, which you ain't by your words, you'd know one argument without being told. Bringing a thing like that home, regardless of what it's called, is grounds for divorce. And how!" He pointed at Sugar with his pipestem. Sugar, flushed and joyous, caught Yuri's eye, her laughing glance sweeping the group.

"My wife'd beat my skull in if I brought her a, uh, housemaid like that," agreed a middle-aged man with a round, red face.

"How about if you're just free-married?" challenged one of the optimists.

"Just makes it easier for the little lady to throw you outta the house."

"Wouldn't need a wife anyway," grunted one of the youngsters. He looked Sugar over carefully, added, "And how!" Yuri had another brief daydream.

"All it takes is six months' practice," Sugar said jerkily, her feet pattering softly on the gem-hard floor. "Anybody can do it. As you can tell by me. You just need hooves. And a tail," switching it outrageously, turning in the air on each bound. "The horns just come natural. Lots of people have 'em. But the thing you need the most is an audience. Like this one." She leaped straight up beside a shy, plain woman holding a big-eyed baby, put her hands on the woman's shoulder, kissed the baby on the fly, and was gone.

Pausing for breath, she grinned around at them, picked out a strong young girl in pants and said, "Give me a hand. Catch me and toss me straight up." The other was dubi-

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ous, but game. Standing just in front of her, she leaped into the air, folding her legs; the other caught her by the knees and heaved. Another girl might have gone over her head, but Sugar put both hands on the head and pushed away lightly. Landing on her hooves, she bounded forward onto her hands just in front of the startled girl again, pushed off hard, turned half-over in mid air and caught the girl's shoulders just as she was backing away. The girl was nervous but beginning to realize Sugar's precision; she halted and Sugar dressed her turn, landing lightly and easily in front of her, laughing into her eyes.

She was dancing hopscotch with a group of pre-teen girls when Yuri finally decided they'd done enough. An intense, hostile silence closed around him as he threaded into the group of women; they all pulled away from him. His bright smile became a toothy travesty. Calling on all the aplomb learned as a cub reporter in Free Los Angeles, he said heartily, "Time to go, Sugar. Bedtime for you." That was an unfortunate remark. If looks could have killed, there'd have been nothing left of Yuri Koeppels but a spot.

"Really?" she asked. "I don't feel sleepy; just a little tired."

"Mustn't get too tired," he said, straining his smile wider. "After all," he said to the frozen-faced women, "you're only seven months old and must get a lot of sleep, ha-ha!"

"If you say so," said Sugar reluctantly. "It still seems early to me." Yuri writhed at that, but she came away. Taking his hand, she innocently wrapped his arm around her, smiled and waved at her friends saying good-bye as she went. There was an agonizing wait while she kissed every pre-teener in the room, then they were at the door. Sugar flashed one last bright smile back, and they were out, Yuri's back feeling as if he were being stabbed with a thousand icicles.

"Are you trying to get me lynched?" he croaked, imagining the sudden explosion of the women into scandalized speech behind him.

Sugar giggled. "Doing O.K., aren't I?"

"So good you're the most popular person in the building and I'm the most unpopular."

She skipped happily. "Good. That's like you outlined it. You're very sharp, you know?" looking up at him worshipfully.

"Yeah," he grunted. "So sharp I scare myself."

In his apartment, Yuri headed for the refrigerator. His electrosynthesizer, working on air, produced sugar, starch, flour (cellulose for bulk), fats and oils, including cream—and ethanol. Just the basics. Right now ethanol was

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the basic. Pouring out a glass of mix—carbonated ethanol and water—he drank it straight, like medicine.

Sugar watched curiously. "Got some for me?" she asked.

He looked down at her in surprise. "Uh, that's not good for little girls," he said after a moment, then turned red, thinking of the women.

"I'm a capriform, remember? It won't hurt me," she told him.

"Don't you get drunk?"

"Heavenly orbits, no. Bad for the reflexes." She looked around at the clock, frowning. "It is bedtime, though. Energy drinks keep me awake."

"You drink alcohol for energy?"

"Sure. Ethanol, that is. We have liver-type tissues surrounding our intestines—you know the kind. They oxydize the alcohol before it gets into the blood."

She went off to take a shower, whipping off her blouse and looking around in puzzlement for the cleanser. Yuri winced at the thought of taking her clothes down to the laundromat. He set the electrosynthesizer to *ethanol* and sat down, brooding. He just hoped it would work. If it broke the public's resistance to androids, he couldn't really complain. The personal contact should do it, from what they'd already seen. But he dreaded taking her around the live circuit. He could afford to hold out for the fashionable nightclubs—with a large percentage of women in the audience.

Sugar came out glowing, toweling herself. For a moment it almost seemed worth it; her fresh, appealing innocence brought a lump to his throat. Then she glanced distastefully at the couch, resentfully at him, and wistfully at his bed. He froze inside, ignoring her glance. She brought out her brushes and combs, came and stood in front of him, and prattled cheerfully about all the wonderful people she had met, currying herself entrancingly. Yuri found he couldn't ignore her.

Finished, she came and sat down on the chair arm. "I think this is a lot better than being an A/V star; don't you?" she asked musingly, leaning against him.

He became conscious of her warm bare body, the faint sweet scent of her damp fur. "It has its points," he agreed, sweating. "About time for you to go to bed, isn't it?"

There was a brief silence. "I'm not sleepy," she said shortly.

She got down after a moment, walked around in front of him, heaved a deep sigh, glanced at him appealingly, silently gathered up her brushes and combs and slowly carried them back to his bedroom. He heard her arrange them on the dresser. She paced slowly around the room for several minutes, and he heard her sigh again. Then she appeared in the doorway. "Aren't

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you going to bed?" she asked wistfully.

He managed to make his voice sound almost normal. "I've got to do an article for Llewellyn tonight," he said.

"Oh." She came slowly into the room. "I'll wait for you." She paced silently around the room for a minute or two, then began to dance slowly and somehow sadly.

Yuri couldn't think of a single thing to write.

After a long time, five or ten minutes, Sugar slowed down, blinking sleepily. She finally came back to his chair, stood by him silently for a time, then climbed onto his lap. "Tell me when you get it done," she said drowsily. Yuri held his breath for five minutes or so, and then she was asleep.

He picked her up gently, carried her over to the couch, and laid her out comfortably. For a moment he stood looking down on her slight, girlish body and peaceful, childish face. *A sweet twink,* he thought. *Poor little innocent. Just seven months old!* He smoothed her silky fur, drew a sheet up over her, and started for his own bed, heaving a sigh of relief.

"Damn you, Yuri!" She sat up, blinking at him in sleepy anger.

"You shouldn't say such . . ." he began weakly.

"I'd've said worse if I'd known it," she growled. She curled up, muttering about, "Prudes and their Teaching Machines."

The next morning Yuri was up early, and checked through the unicom's records. There was a whole series of requests for interviews from reporters who knew or had learned his Unident number, and a few from friends, cautiously curious. There were also calls from Pepper and Ginger for Sugar.

On the telefax section of the unicom, there were several business offers, ranging from bids for Sugar to queries on rentals, both from private individuals and from booking agents. One prospective purchaser was an aging, wealthy socialite who affected a gold-plated astromobile. There was also a cautious message from Llewellyn, requesting a public statement, if not an interview. Pan Solar would have liked an article on the future of androids if possible. That must be handled very delicately; it was for the family newspapers.

"He's telling me?" muttered Yuri. Sugar awoke about then, cheerful again. She gave Yuri a good-morning kiss, and he put her to work on breakfast; she had mastered the apartment's simple cooking equipment quickly. She returned her sisters' calls. Yuri brooded over the publicity problem, finally decided to avoid all reporters for a day or two, to make a public statement, and to write an article tying in with it and Frolich's "theory" that androids were "nothing but" better than robots. The public statement was simple; it had been outlined by

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Frolich the day before. Basically, he had bought Sugar on spec and had options on her sisters; he would promote them as dancers, exactly as a man with a troupe of robo-puppets would. Frolich would back him from the other end, saying that Yuri was the natural choice for manager, as the girls knew and liked him.

The article had to cheerfully assume that androids would never be free, without coming out and saying so; and Yuri was careful to work in the opinion that had been growing on him, that all record companies would soon be producing their own androids. That hit the Actors' Guild from both sides; their actions condemned the girls to slavery without actually protecting their own jobs. Finished, it looked like something that might be found in a girlie magazine. He telefaxed it and the statement off to PSN quickly, before he lost his nerve.

During breakfast, he and Sugar read the papers and watched the news. In general, the sale of the beautiful android had unleashed pandemonium. Expressions of outrage were made by a large number of influential people, but Frolich had discounted their protests against the Actors' Guild suit; people pay no attention to moralisms when their jobs are threatened. Other expressions of outrage, however, were more important. Reporters had descended on the Spire apparently just after he and Sugar had retired. They had tramped the public rooms until midnight, questioning everybody, and many newspapers carried one news service's poll of the Spire's occupants on the ethics of the ownership of androids —reaction overwhelmingly negative.

"It's working even faster than I thought," sighed Yuri in relief.

Sugar said, "They came around and questioned Pepper and Ginger again last night. Can you get the interview on TV?"

"Should; I always leave it set to record news." Yuri checked through the TV's record index, found *androids* mentioned under News Briefs. He tuned to it and the wall opened on the lounge of Dr. Birrel's astromobile. Sugar caught her breath at sight of the familiar room. Pepper stood in the center of the visiplate, pouting; Ginger was curled sullenly in a lounger farther back. Sugar started to giggle at their expressions.

"What do you think," came the voice of the reporter from behind his icon, "of having your sister sold like that?"

"I think it was awful, and if she shows her head here again, we'll dehorn her," flashed Pepper hotly.

"What?"

"You heard me," she said clearly. "It was a sneaky trick. Not fair!"

"But *he* bought *her!*" protested the flabbergasted reporter.

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"Ha!" exclaimed Pepper.

"That's right," Ginger agreed angrily. "She's the one talked *Him* into selling just one of us at first, because Yuri couldn't afford the down payment for us all. We never knew anything about it until it was all over with."

"You really mean you see nothing wrong with being sold?"

They looked at him as if he were a cretin.

Ginger said, "If *He* wants to make some credit off us, well, *He* earned it. We're here, aren't we?"

"Well, but what about future androids, androids made by other people. Unscrupulous people who'd sell 'em to anyone with the credit?"

Pepper looked at him, shrugged, turned and marched back to the lounger, stamping her hooves and switching her tail angrily with every step. "Ask the Actors' Guild," she growled, curling up beside Ginger.

"People will do whatever they want with them no matter what we say. We've got our own problems," Ginger agreed.

"If you see Sugar, tell her to swim the Atlantic," said Pepper. "Yuri, too!"

Yuri joined Sugar in laughter, but said worriedly, "They're not being innocent enough and they're not making me out to be enough of a monster."

Sugar gripped his arm. "They had to play it that way," she said. "After the image we've projected, they couldn't act shocked; it would seem phony." She grinned impishly. "They're putting on a good act, too, aren't they?"

Yuri found one other significant reaction to yesterday's news of the sale of Sugar. The Actors' Guild had requested a continuance to rephrase their plea. The judge had denied it, but he had recessed until noon to "study the issues." Frolich's plan was definitely working, at whatever cost to Yuri; His Honor was undoubtedly considering the next election. Yuri was quite cheerful as he began to call up booking agents.

Sugar, at loose ends, took their clothes down to the laundromat and made the rounds of the eighty-ninth level's public rooms. Yuri watched her on TV later; she made it a point to avoid reporters' questions. The public appearance was eminently successful; feeling against Yuri did not decline much, despite her evident happiness.

Newspaper reporters got to Ginger and Pepper and finally made them admit that selling androids was bad—for the androids. The afternoon editions were filled with gloomy pictures of future android slavery in both gray and purple prose. Yuri's article was the only one that seemed cheerful at the prospect; it replenished the monster image with a vengeance, and the left-handed crack in it at the Actors' Guild drew blood.

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All the Inner Planets tuned into the courtroom that afternoon. The trend of public opinion was obvious, and judges who have political ambitions must seem to lead the pack, not follow. The Actors' Guild's suit was dismissed on the grounds that the androids were "intelligent, reasoning beings, a subspecies of Man; that human rights, under the law, must be extended to all intelligent beings, whatever their form or origin."

Yuri gave Sugar a hug. "We're home free, Twink! It's going a lot faster than I ever thought it would. I'd say androids are about accepted. I expected it to take at least a week, and maybe as much as a month."

"I wish it would take a month," said Sugar. Looking disgustedly at him, she added, "Not that it would make any difference."

An hour later Yuri received two telefaxed messages: ALLEE ALLEE OUTS IN FREE—FROLICH. The other read, YURI SUGAR COME HOME ALL IS FORGIVEN—PEPPER GINGER.

The morning newspapers, the next day, showed a picture of a cheerful Yuri arriving, late at night, at Cheviot Preserve; they had been detained by a farewell party at the Spire. The captions were variations of Still Cheerful After Demotion—*from Android Owner to Android Press Agent*. Other pictures of Sugar were captioned Slavery Apparently No Great Ordeal. Yuri read them at breakfast, between sessions of watching the girls.

He had come in late that morning and ordered Sugar to get breakfast. They looked as fresh as flowers, though he suspected they had sat up until midnight while Sugar told them everything. Ginger promptly kicked him in the shin, her sharp hoof sending a wave of agony up to his knee.

"Don't speak to *us*, Yuri Koeppels! We know all about *you*," she said indignantly.

"We don't associate with robo-puppets," Pepper told him with dignity.

"I thought all was forgiven?" he said, wincing.

"We're mad all over again," Pepper told him. "You insulted our sister!"

Frolich came in late—he had had to leave his airmobile outside the Preserve—and called a business conference. Ginger and Sugar showed up, dancing and trying to trip each other. Yuri went after Pepper. He found her in the lounge, and at first assumed she was asleep. She was lying on a relaxer, waving her feet in the air and weeping quietly.

His heart turned over and went into a power dive. "Pepper, honey," he said, feeling miserably inadequate. "What's wrong? Don't cry, Twink. Tell me about it."

She lifted a wet, surprised face. "What's the matter?" she asked.

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Taken aback, Yuri asked, "What's the matter with you?"

"Nothing," she said, more surprised every moment. "I was just crying."

"Well, but what were you crying about? Is something wrong?"

"Of course not! Everything's wonderful. Don't you ever cry?"

"Not if I can help it. Certainly not without reason."

"Well, I had a reason. I just felt like crying, that's all."

"What makes you feel that way?" asked Yuri, curious.

She shrugged and smiled, piquantly. "*I* don't know. I'm happy, and sad, and I think how I wasn't even alive seven months ago, and what a wonderful world it is, and I just naturally cry. Anybody would."

"I guess they would, at that," said Yuri slowly. "Maybe I better leave you alone, then."

"It's O.K. now; I'm out of the mood. What was it you wanted?"

"We're holding a business conference in the conservatory. Care to join?"

"If you'll carry me." She reached for him. "I'm out of the crying mood and into the being-carried mood." She had that listless, comfortable feeling you get after you've had a good cry. He grinned and picked her up. She wiped her face on his shoulder and was contentedly silent as he carried her into the conservatory.

"Shame, Pepper!" cried Ginger. "We're mad at him!"

"I forgot," said Pepper unrepentantly.

"Incorrigible," sighed Ginger.

Sugar shrugged wryly. "Both of them. But she's our sister and he is Yuri." Resignedly, they started to join Pepper and Yuri in the lounger.

"Hold it!" said Yuri, catching Ginger by the horn. "You may have forgiven me, but now I'm the one who's mad. You kicked me in the shin!"

Ginger halted, shamefaced. "It was just a joke," she protested meekly. She sank penitently to her knees and rubbed the offended shin, only half in jest.

Yuri looked down tenderly into Pepper's peaceful face. "I never fully realized how tragic it would be for androids to be bought and sold until I saw you crying," he told her, rubbing Ginger's head.

Ginger piled into the lounger beside him. "Don't mention it," she said. "I'm glad *that's* over with."

Frolich looked up in surprise. "Over with? What gave you that idea?"

"Isn't it?" asked Yuri tensely.

"For these girls, I think yes; they're accepted. But the battle will no doubt have to be fought all over again with each new form. Can't you just see General Oceanics getting its mermen to sign lifetime contracts the minute they come out of the incubator? I hope you don't think we've changed the shape of the human race." ■

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THE visitors

"Primitive" being a term impossible to define, you can bet the first contacts with "primitive" aliens are going to be sophisticated surprises!

JACK WODHAMS
Illustrated by Kelly Freas

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"Play that section over again."

" 'On approach to intelligent alien life forms'?"

"No, no, before that, the part about alien intelligence levels." And Stuart Evison stared pensively at the screen, at the world that was not really expected passing below.

"Ah. 'The anticipation of intellect comparable to the human scale,' that bit?" Senza asked. She ran the repeater back; kicked it off again.

" 'The intrinsic mental capability of humans has known no marked increase from earliest historical times; a man born early or late would still have the mental capacity to adapt to his time and circumstance. Experiments to evolve persons of greater intellectual ability have not, where successful, been notably beneficial. A preponderance of individuals of high intelligence does not automatically imply an improvement in general rational reliability, an addition advantageous to society. On the contrary, it has been found that an abundance of persons of high I.Q., vying with each other, have a strong tendency towards contentiousness and, in the divergence of their many-faceted views, are disruptive to the human condition rather than constructive.

" 'Instability is concomitant with very high intelligence, and the concept of an earth peopled entirely by persons of, say, double the present average human I.Q. is unrealistic and impossible to contemplate —the fractiousness of competition would result in utter chaos. Humans have developed, in stages, accumulating and consolidating their knowledge for use, rather than to have grown cleverer and cleverer in actual brainpower. Socrates would not be lost today, mentally,

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but he would be lost *technologically*.

" 'Now we are reaching for the stars. Our mental superiority to our ancestors is negligible—merely we have acquired technical knowledge. Intelligent aliens, therefore, need the furnishing of no greater brain-power than our own in order to achieve what we have achieved, and differences in relative mental capacity can be anticipated to be minor. Knowing that this approximate equivalence will obtain, any seeming disparity, evidence of either lower or higher sociological order, must sensibly be construed as the result of technological, not mental, paucity or progress, whichever the case may be. With this understanding . . .' "

Stuart pushed a hand emptily. "Cut it, cut it. The damn fool doesn't know what he's talking about." He turned to face his crew. "That was worked out by an I.Q. 120 mind that wanted to convince itself that it was not too far from the stable ultimate. But what if *they* have found a way of reconciling a higher general level, of an average I.Q. 200 mind, say? Or I.Q. 250? Or I.Q. 500-1,000 minds?"

"From what we've seen and found out, those here are unlikely to fall into that category," Chug Parker said. "All the evidence points to their being at the beginning of civilization."

"Does it?" Stuart gnawed his lip. "How can we be sure? Just because there's no space junk lying around? Just because they seem to have no radio communications system? There's something about the layout of the towns and small cities on the Pear continent—they're neat and tidy, well organized. Who can say whether their seeming simplicity is early developmental, or late and supremely philosophical?"

"I don't think there's anything exceptional about them. They're behind us, but ahead of others of their kind down there. Fancy buildings and such don't mean anything—the Greeks had them, the Arabs had them, columns and minarets and so on. What's here is just local style. Their farming and fire-burning does not suggest a futuristic culture."

"I wish you'd stop drawing parallels," Stuart said. "It was all right to speculate at home, make jokes, even—but those who drew guide lines had no conception of the psychological angles that confront us now. How *do* we go about this thing? Up to now the advice format has seemed sensible and reasonable—but *now* we are here, and suddenly it is shockingly apparent that the contemplated straightforward design for procedure was thought up between coffee breaks by nice, safe, logical people."

"You're afraid to land?" Chug Parker was blunt.

Stuart averted his eyes, came back. "Aren't you? It sounds so

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easy, just drop in. O.K., so we've checked everything that it's possible to check from our sweeps up here. All right, the environment seems to offer no great complications." He began to feel hot. "It would still be very dangerous to land—and what purpose would it serve, really? We've gathered an enormous amount of data, which will stagger those at home. At this stage, the usefulness of a landing is highly debatable."

"To come all this way, to actually find an inhabited and inhabitable planet, and not to land . . ." There was hunger in the eyes that Chug turned to the screen. "We *must* land. To go home and tell them what a compatible world it is, but that we were afraid to set foot on it . . ."

Stuart rounded on him. "Who wanted to go back when we broke into Nothing, huh? Turn back, reverse cycle, go home before it was too late?"

It was Chug's turn to redden. That had been a bad time.

Everything had, of course, been calculated with the greatest precision right down to the most minor detail. On computed automatic they should have been wakened a little before .1 parsec of their F5 target star, Procyon.

Explorers. The first trio of craft to reach beyond the solar system. One to Alpha Centauri, one to Procyon, one to R Ceti.

And the crew to Procyon had been wakened—to check and perhaps finely adjust course for a closing second leg of the journey. Routine, go back to sleep. But they had been awakened in Nowhere, too soon, instruments seeming to read correctly, yet crazily not. They were not where they should have been. And given an instant sense of being lost, space at once assumed the awesome grandeur of its infinite vacancy, striking and intimidating and overwhelming, hanging the jaw and shriveling the guts. Everything to be lost on their first gambling throw.

Chug Parker had cracked. He had wanted to re-track, to get back, to return home. The emptiness ate into him. He had argued against delay, had pleaded the hopelessness of continuing. Home, try to get back home, the only sane thing to do, it was madness to keep going. And Chug had infectiously surfaced the fear in all of them. There had been a period of snapping tension, with the threat of panic, especially to Charyl Grouth, the younger woman.

Stuart had pulled them out of that. Clawingly chilled, he had brutally forced upon himself a calm, had curbed his volatile mind to singular, deadly cool appraisal. Under stress, it had been his verbal hand that had slapped them back to sense, his maintained cold and clinical attitude that had held them, applied them, dedicated them to

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specifics. As to a man stuck on a cliff, Stuart had kept their eyes from looking downwards, had kept their eyes to the immediacy of finding handholds, thinking of nothing else, concentrating their minds and his upon the finding and correction of the error.

It had taken them three exhausting interminable weeks to derive an acceptably probable answer.

"That was different," Chug said. "Out there there was nothing, we were lost. But we *could* have backtracked our course," he defended, "and it *would* have been quite in order for us to have done so. But you chose to carry on. That was a far more dangerous decision to make than this one. We've found this planet, Stu. We *must* land on it. We just cannot return home and admit that we didn't put down."

"When we were out in Nothing we did not have a great deal to lose. It was as well to solve the problem on the spot, and we had nothing better to do. But here we have garnered information of incalculable value, and certainly our journey has been fantastically well-rewarded. The risks we have taken have been sufficient. We have no truly justified cause to land. A few samples of strictly local flora are not warrant enough for putting the ship down."

"But Stu . . ." Chug's fists clenched and unclenched. On screen, far below them, the world crept slowly by, long streaks of cloud obscuring the ground here and there—a world tinted blue. So like home. "I don't care what you say. We should land, Stu, just for a little while. Our atmospheric tests are not good enough. We need to strain and bottle some ground-level air. Suited up, we'll be sterile and we won't contaminate, or be contaminated. And we should try to make some sort of contact with the life down there."

"Oh yes, get a sample of their speech, if they have a speech," Stuart almost jeered. "'Say a few words, friend, a whole dictionary full, huh?' I can see it. Make contact. It sounds so easy, doesn't it? Just where do we start?"

"We can't start up here," Chug shot back, "and we *need* closeups of them. Whoever comes after us needs to be as comprehensively armed as possible."

"They would either run and hide, or start throwing rocks," Stuart predicted. "In case of trouble we have a couple of lousy pneumos. We have no glass beads, even. Aliens are a joke, didn't you know? If you meet any aliens, shake 'em by the mitt and wish them luck from the Great Twolegs from across the galaxy. That there *are* aliens, that, as forecast, stars are more or less bound to have planets for the sake of their equiliberiums, these are not as yet readily accepted theses. Now here we are in an unprecedented situation,

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and *I* say that we are simply not equipped to pay a social call. I think we should be foolish to do so."

"It's more than that. You're thinking we might run across a local pet cow which might eat us all up. There *are* risks, I grant you, Stu, but they're no greater than what Tasman faced when he landed in New Zealand. We can blast off out again just so long as we're all aboard."

"Yes." Stuart puzzled. Why was he afraid? Xenophobia? Everything down there would be different, not a bird, bee or blade of grass would be the same as those on Earth. But were they ever? No, it was the aliens. Primitive or not, they were intelligent beings, and some primordial instinct within him was reluctant to recognize in another species attributes hitherto thought to be exclusively human. "We're not tourists. We're here to do a particular job of work. We have done this job thoroughly. We were not meant to be ground surveyors. We should start for home as soon as we can. To be honest, with the limited defensive resources that we command, I think we'd be insane to land on this planet."

Senza Kelsey spoke up. "Stu, sanity is not an overriding human trait. I agree with Chug. Wise or not, I think we ought to at least set foot on shore. With the five weeks conscious we had before arrival, and the three weeks circling since, I long for land, Stu. To have something substantial under our feet once more."

"If we set out for home now," Chug said, "it'll be another four weeks conscious, at least, before we hit dirt again. You talk of sanity, Stu, but"—he gestured screenwards—"there it is, solid. I've been drooling for it ever since we arrived. I ache for it. Stu, don't you feel it? Earth, soil, reality, lakes, greenery—there! And we are cooped up in this tin can. It may be insane to land, Stu, but I say we'd be plain crazy not to."

Stuart looked to the last crew member. "What do you think, Charyl?"

She looked to Senza. Then back. "You're the boss, Stu, and I'll abide by your decision. But, if you are prepared to accept the will of the majority, then the vote for a landing is three to one."

Stuart looked from face to face. They wanted to land. The responsibility was his. His resistance, he had to admit, was not powerful enough, was rather subjective than objective. He took a deep breath and nodded. "Very well. We'll land."

Taut strings play the most poignant music. On the last stages of the descent Stuart found himself thinking of Leif Ericson. *And three or four hundred years later . . .*

There was excitement aboard the ship, too much excitement, sup-

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pressed, but evident in shining eyes and quick movements—even in the atmosphere. Carefully selected people—that cross between sobriety and flair that has the knack of supplying the correct which of the two at the right time. Now they were on edge. Two conscious months in space, with the vacuity outside clamping tighter and tighter on their vessel, their world cramped, becoming so completely known in its detail as to become constricting in its screaming familiarity. And surrounded by space, unusable space that shrank every soul that attempted to comprehend its volume.

Landing on a planet. Not the dead Moon. Not the barren Mars. Not any of the bleakly inhospitable worlds of the home solar system. No, *this* was a *live* world, containing living things, sentient life, vital life, with all the incredible and astonishing variety that that meant.

They descended, descended, and lips were licked, and fingers twitched, and muscles betrayed strained nerves. From Jason to Cook to Willdovsken, seeking to set foot where no man had trod before. Only this time so total . . . Down, down, instrument watching, adjusting, the terrain seen through the scanner growing sharper in detail, growing less blended in color, growing. The unmistakable demarcations of patches of cultivation, the wink of water, trees, bushes, scrub, the lines that meant pathways, closing, closing, huge, a world, a mighty mass of reality.

It looked good, by Gordon's oath, but it looked good. It was so gloriously tangible, so enormous, spreading, brown and yellow and blue and black and green, green so beautiful a color. The land seemingly opened to them as they fell, satisfyingly, gratefully, to give meaning once more to height and breadth and length. Wonderful, wonderful substance.

Their chosen clearing, a flat stretch of pale yellow, darker, patches of green, gray, shadows, coming to meet them, field narrowing, horizon rushing in, and what had been inanimate, an object for dispassionate scientific study, in a critical moment of proximity made magical transition to a new dimension. As Alice stepping through the looking glass or, no, rather as an eye at a microscope that should suddenly become a mind on the specimen slide.

They dropped, and the picture could be seen now to have movement, and what had been truly real, but static, now sighed and breathed. They had dropped as into life.

They touched. The pads tested the surface for resilience. The ground was firm. Delicately the ship eased its hydrosprung sinews and relaxed. Gently its tail settled, held, compensated balance, and locked itself to rest.

They were down. After two con-

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scious months of endless journeying. They had arrived somewhere. They were down. The drive had cut. They were on a planet. Now, after what seemed an age, they were no longer going anywhere, were so longer moving. They had stopped. And that was the most peculiar thing that they were aware of—that they had stopped. After such time when they had not been physically conscious of motion, to feel the sensation of coming to a halt was most odd.

Inside the craft was hush. Stiffly, mechanically, Stuart tuned in the outside viewers, switching all three from the wide vertical to the long horizontal.

Stillness. No—movement, that rippling, that waving, that bending, subtle with a breeze. Tufty grass, grass? Yes, and small clumps of spiky stuff, and stunted flat-topped shrubs like upside down umbrellas, canted, twisted, frozenly blown upwards as by an underground wind. And not too far off trees, tree-like trees, some tall ones, one nearby that had drooping limb-tips, another a pillar of holly-green with errant nobbles here and there, and another further away, arched, had a golden tint to it, as of autumn.

Nearer, dust kicked up by the ship drifted and settled. There were sandy-looking areas, and to their northeast a shallow outcropping of russet rock, and behind that rising ground. To the south and west calm vegetation, the greatest density of trees, the ground again gently rising. To the southeast, relatively open ground sloping down a half kilometer or so to meet a sparsely-clad bluff. To the right of the bluff, just visible, a couple of low buildings, the outskirts of a village-town.

As scenery it was not strikingly magnificent—but it *was*, it was actually there. Dirt, matter, chunks of it, loads of it, miles of it, so reassuring in its massiveness, so comforting in its interposing, creating an insulating perspective that cut space in half, making *up* and *down* valid, forming a vast platform of security from which the limitlessness of the heavens could be regarded again with some equanimity.

Chug Parker began to tremble, and the level-headed Senza began to weep from open eyes. From Charyl Grouth came a choking sound. Stuart alone seemed untouched and, not for the first time, his own feelings baffled him.

Chug's shaking became near uncontrollable. "We're down!" He laughed. He hugged himself that he might not vibrate to pieces. "Oh, boy," he breathed. "Oh, boy." He didn't know what to do with himself for a while.

Stuart knew what to do. He had prepared. He broke out the cups and tore the seal from one of their precious rumpacs. "Come on," he said, pouring, turning on the genial cheer of a host, "this calls for

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splicing the mainbrace. Here, Chug, get this down you . . . Hey, don't waste it!"

So they celebrated. There was talk, loud, and a boisterousness that they had never before known together. "Look," Stuart cried, and he stomped his feet and jumped. "Gravity. Genuine honest-to-goodness gravity!" And he stagggered and nearly fell, and old reflexes slammed his hand to support. *"Whew!* I've gone dizzy. Out of practice, I guess."

The gravity *was* quickly noticeable, dragging at muscles become unaccustomed. And the drink did not help. It worked.

Soon the high spirits abated and, seated now, they quietened to more solemnly thrill to the view. Their voices were lower as they peered, and their training began to show, and they began to notice this and to point out that. A small fawnlike animal, blotched black-on-ash, not at all frightening, broke cover briefly to cross the downward slope. And some birds arose to beat away to safer haven in the west. Animals, birds, they were good to see.

"We'd better prepare to operate the recorders manually," Stuart said. "The . . . what? People shall we call them? The people from the town should be here shortly. Unless they're blind or lack curiosity. Don't know how close they might venture, but if we're to get speech samples you'll have to be slick on the audio pickup, Chug. Charyl, you'd better operate the zoomer to specifics while Senza works the breakdown splitter. Me, I'll start taking filter samples, et cetera, of the local lung mixture. That way I can keep an eye on you all, right?" He grinned.

He had a nice grin, Senza decided, and it had been absent too much lately. "All right, Stu." A strange man, unpredictable—but weren't they all? A man nagged by self-doubt yet, in the crux, the one to turn to.

Their landing fever eased, they made ready to assess their visitors.

How does alien look upon alien? Much depends upon the vantage point. The first sighting amused those in the craft.

From the southwest, from out the undergrowth, came two little ones, two hundred to three hundred meters away. They stood stock still and gazed at the ship for a full minute. Then bursting out from behind them came larger ones, gathering the smaller ones to them, snatching and dragging them back. Chug caught the high pitch of the chatter. It could be so readily interpreted, was so natural, so normal. Almost human.

The adults of the breed could then be seen filling the left-hand fringe. They were mostly silent, content to stare their fill at the sleek monster that had come into their midst.

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"Primitives," Senza said. "Coarse clothing, what could be armor on the nearer group, fancy ornaments on the ones behind. That thing like a 'W' with a handle, with a long middle tongue, yes, it's flat, undoubtedly a sword of some kind. No camera, radios, eyeglasses even."

"Yes?" Stuart said. "Even so, they'll have a few things that we haven't thought of, you can bet your life."

"If I started the siren," Chug smiled, "they wouldn't stop running till they got to the next county."

"Hm-m-m. I hope you're right. It could come in handy." Stuart tapped Charyl on the shoulder to sneak a direct close-up on the zoomer selector. "*Phoo.*" The clothes they wore. They reminded Stuart irresistibly of the formal attire worn by the participants in the Chimps Tea Party at the Zoo. Not that they looked like chimps, but definitely a parody of humans. No, that was not right, Stuart told himself, was unfair—but despite himself the idea clung.

The aliens—who were the aliens here?—the indigenous people looked to be generally tall, two meters at least according to the sight gauge. They were upright bipeds of comparable human configuration, but the differences . . . Many without footwear could be seen to have lumpy, long-toed feet, with thick mottled lower shanks that . . . Why, they were like the legs and feet of some monstrous fowl. Their arms, too, seemed scrawny and tough-skinned and lacking the fattening of flesh. In contrast to their limbs, their bodies had some rotundity. And the head. The head was a bullet, small ears, small wide-apart eyes, a long narrow nose ridge two slits just above and the width of a shallow-jawed mouth. Bald to where hair started to grow back from the nose flaps-cheeks and towards the back of the neck, under the jaw. Weaselly looking in a Mongolian way.

"Well," Stuart said, "there they are. If they have humanlike traits, they will gradually come closer. And, if nothing happens, they'll eventually get close enough to touch and examine this weird vessel. And, if still nothing happens, they'll soon start sawing off chunks for souvenirs. That's if they're anything like human."

"There seems to be a lot of similarities so far." Chug focused the audiceptor. "From the variations and inflections, they have quite a complex language."

"Uh huh. We'll be in no hurry," Stuart stated flatly. "And we are not going out there until Senza has correlated the psychology behind their every wiggle and every fidget . . ."

Stuart was tempted to name the aliens Monkols, and then Chickfoot, but with laudable prescience he

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knew that the name he gave would probably stick, and that such title might prove everlastingly derogatory. Thus he chose to bestow upon them a name with no belittling connotations—simply, the Prokind. He had to keep reminding himself that *they* were not aliens, not here.

Every observation revealed that in many ways indeed the Prokind behavior pattern bore relation to that of humans. It was deduced that here they were country types, on a level perhaps with medieval Europe. They had one or two general mannerisms that were uncommon—they broke peaceful contemplation to spasmodically wrench at their dress and maybe stamp a foot a few times. As the Prokind grew bolder, the more daring elements stepped out, albeit cautiously, to—with brave seeming casualness—advance a pace or so further into the open. The tugging at clothing and foot-stamping, with the head bobbing, tended to increase, but was not, the humans decided, a building manifestation of aggression, but rather evidence of relaxation, the nervous release of tension. Or, as Stuart remarked, it could be the result of fleas.

"I don't know," Stuart said. "What do we do, lower the drawbridge? They'd probably scatter. On the face of it their approach to the unknown is as sensibly tentative as it should be. But what can we do about it? Communicating with them is an insurmountable problem at this stage, and what could we tell them anyway? There's no point in playing god to no purpose. It may gratify our sense of superiority, I suppose, kindly old Uncle Human from eleven light-years away, but with not the least knowledge of their customs or the state of their affairs, what we may beneficially contribute is a matter of purely academic conjecture."

"We can try sign language," Chug said. "We can try to establish our peaceful intentions that those who may come after us may find welcome."

"Ha." Stuart was sardonic. "The high-principled entrepreneurs who follow in the wake of the noble discoverers." He brooded at the screens. "Poor devils. They don't know what they're in for. A superior culture is on its way, and soon they'll be dancing the risky knee-twine and drinking Golp's burple. Oh happy day of enlightenment."

Chug changed the subject abruptly. "How's the air out there? The filters picking up anything disastrous?"

"Not superficially. We have to go out, don't we? Well, breathable as it is, you'll have to be suited up, so you'll not be able to escape our hygienic but monotonous smell. We can't risk any one of us becoming a carrier." Stuart smoothed an eyebrow. "O.K. You should have enough gab for them to work on by now. You want to go for a stroll, w-e-l-l"—he shrugged—"if

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it's to be done . . .The response might be interesting, at that."

The nearer Prokind formed a loose half-circle about fifty meters down from the ship. Behind them straggled the less intrepid, according to their degree of apprehensiveness. Newcomers were arriving all the time.

In the center now were gathered the half dozen or so armored ones. Their armor was assorted, only their weapons more or less of uniform design—except for one who carried what looked like an overgrown sharpened tuning fork. In the center also were the two most colorful figures, persons of some local stature no doubt. They had been tardy in joining the vanguard, but the quiescence of the craft had maybe persuaded them to assume a position more suited to their standing in the community. These two certainly now felt it incumbent upon themselves to hold forth, and their audience appeared to be listening with respect.

The air-lock door cucked open, and steps extended down to the ground.

There was an immediate stunned stillness, not a scratch in the place. Then the suited Chug appeared in the doorway, groped gingerly for the first downward step.

Pandemonium! As one the Prokind turned and legged for cover, the presumed chiefs thrusting and trampling mightily to diminish their pre-eminent proximity.

By the time he reached ground level, Chug had the place to himself. "So much for sign language," he said.

Stuart was monitoring him. "They might come back. Whether they do or not is immaterial. Just don't wander too far away. We can scare them with noise and flashing lights, maybe, but otherwise there is no arsenal here to get you out of trouble."

"O.K., Stu, O.K." Stuart could hear Chug breathing hard. "Boy, but it's great to stand on dirt again."

The air-lock door opened once more. Charyl, her suit damply shiny from the sterilcote, came down to join Chug. She, too, breathed deeply, sucking in the stale suit air as though it were balm from the mountains, and through the alchemy of sight and imagination she found the quality surprisingly satisfying.

"Remember, keep close to the ship."

"O.K., Stu, O.K."

The two outside looked at each other and beamed. There was something tinglingly conspiratorial in that glance. The land felt good underfoot. The suits were cumbersome, impeded walking, and such exercise was anyway rapidly tiring. But they did not want to walk far. It was sufficient to stand on *real* ground, and look up, and sideways, and around, and see *things*, things everywhere, to know that

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there were things beyond, things spreading in all directions for miles and miles and miles. So much lovely room, so much lovely freedom.

Contentedly and with wonder, Charyl bent to touch the soil with her gloved hand. Fascinated, she set about the task of gathering samples of the plants in the vicinity. Chug kept guard, taking a pace or two, this way or that, feeling more alive than he'd felt for ages. This was where a man belonged, on the ground.

From the brush, from behind trees, the Prokind could be seen to be keeping bated surveillance. Chug chuckled. They were a funny crowd. They ran in a hoppy-bounce way that was something to see. Chug waved to them cheerfully. "Hey, Stu, I'd give your pension to know what they're thinking now."

"They're thinking that you might go off bang at any minute. Keep your eyes open and don't be too overconfident. They have arrows, maybe—and there's the secondary direct danger of possible tiger or grizzly equivalents to consider. Finding anything interesting, Charyl?"

On her knees, Charyl paused and put her wrist to her faceplate. "It's *all* interesting. I have about thirty specimens already, and I've hardly moved. Two spider things and a little bug . . . Stu, it'll take *ages* to do a comprehensive study."

"Just a cross-section sample should be all we need to work on back home. Don't forget the little bag of sand."

"I won't."

Chug gazed up at the sky, clouds, white, the sky light blue—Was the sky at home as light as that? Hard to remember. Like some of the greens, they were very dark, and yet others were so pale, like the gills of a seasick cleric. Silly the way no two plants could decide the efficiency of a single coloration.

Chug saw something, tucked his pneurifle under one arm, and stooped. He picked the flower and straightened. It looked similar to a daisy. He twirled it before his eyes. It did look very much like a daisy. But it was not a daisy. Daisies grew on Earth. And this was not Earth.

The flower was pretty. But it said not Earth, and this one pretty, frail thing imparted a message of sadness. A delayed reaction to landfall struck him. The daisy swam before his eyes and a tear spilled to run down his cheek, and he felt such a big fool. But Earth, this was not Earth, and that seemed to mean so much.

He let the flower fall, and sniffed. Stupid. He couldn't get at his face and the streaks would show, stupid fool. A grown man going soft over a daisy. He turned up his thermostat. He'd walk about, get hot, sweat so that it wouldn't show. Damned daisy!

"I didn't catch that. You all right, Chug?"

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"Yeah. Oh sure, Stu. The, uh, natives seem content to watch the floor show, don't they?"

"Stu," Charyl squatted, "I'd like to get some leaves and bark from some of the trees, to broaden the range. But I guess that's out, huh?"

"You got it. They're a bit far. You fall in a pit, get caught in a local animal trap, get jumped and gobbled by a local carnivore—I can think of a hundred reasons. It's as safe as a bank out there—a Depression bank. All being well we'll be here for a day or two. We may be able to extend our field of operations later. I want to go walkie too, remember. Softly, softly, catchee . . . Hullo! What's this?"

Into the lower end of the clearing a fresh group of figures had appeared. These were Prokind, but they were mounted upon large animals, thick-legged beasts like baby elephants with ugly boxlike heads on necks of folds, as innumerable double chins.

"This is a different crowd." Stuart's voice took on a sharp edge. "Very gay and smart, cloaks, headgear. And those long prongs are lances of a kind. Charyl, get back in here."

Charyl did as she was bid, crabbing to the steps, keeping one eye over her shoulder.

After a pause to take stock, the mounted Prokind began to advance steadily up the slope.

"Chug, I've a feeling that this crew is of a different caliber. The local baron, two-star general, king's rep or tax collector. If you're wildly keen to want to try to parley, do it from the open lock."

"Right, Stu." The lock-door closed on Charyl and Chug backed up the steps, his weapon easy in his hands.

The Prokind kept coming, drawing the townsfolk out at a respectful distance behind them. The lock door opened for Chug.

The mounted Prokind halted less than twenty meters away.

Stuart's voice came meditatively to Chug. "This is what is known as a Green Viking—a Norse of a different color. This breed are like the knights who went out to fight dragons. They may be scared stiff, they *are* scared stiff, but they won't show it. These will be the overlords, the protectors of the people. And their overlordship may not permit fearfulness. It tallies. They've got guts, unreasoning guts maybe, but guts nevertheless. Take no chances, Chug."

"I won't, don't worry," Chug assured him.

The leader of this fresh band of Prokind spent some time making Chug uncomfortable with his stare. Then this fellow, tall even for a Prokind and looking impressively enormous in an enveloping ripple-draped gray fur garment and square-brimmed hat full of upright spikes—a camping seat for a fakir—calmly climbed to stand upon the back of his charger.

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"You have to admire his nerve," Stuart said. "He doesn't know what it's all about, but he intends to find out, begad. Cheeky so-and-so. Here he goes—I'd better get this."

The Prokind chief began to speak, in rather a high voice, but in a seemingly well-paced and articulate way. Whatever he was declaring, little humility showed through. Standing upon his peculiar beast, himself an odd figure, his attire ludicrously bizarre, his speech a garble, he yet amazingly projected dignity and the faintest hint of truculence.

"He reminds me of a Spanish don," Stuart whispered in awe. "He has the courage of the unthinking. They're backing him up, but only just. You've got to hand it to him. Uh-oh. Now it's your turn, boy. Start waving your arms about."

Chug had forgotten to turn his thermostat down and he was perspiring enough to be pre-disposed towards embarrassment. Sign language yet. He bowed to the figure before him. He pointed to the sky, made swooping motions, patted the ship and smiled fatuously out through his faceplate. He placed his free hand to his heart, threw his arms wide to welcome them and used his free left hand to openly appeal. He wound up with another deep bow.

His performance was greeted with great lack of enthusiasm, sinking blankness. He felt like an idiot and his boots began to get squishy with sweat. There was a long silence to underline the total absence of response. Had he been performing at Carnegie Hall he could not have been more acutely aware of his inadequate showing. Then the Prokind leader began to speak again, a note of demand in his tone.

"I think you had better retire with what grace you can muster," came Stuart's advice over Chug's speaker. "We'll get what he has to say and answer with a spurt of Tchaikovsky's 'Nutcracker'. Or maybe Charyl's Weng Ki special, 'Chop Suey Chops', huh?"

"Anything," Chug said, edging up to the last step but one. "Stu, it's awful lonely out here of a sudden."

The Prokind ceased speaking. Chug stopped also. He felt that his discreet retreat had been only too keenly observed and interpreted. And in a simple fluctuation of human desire, he began to wish that he'd never set foot on shore.

Without turning his head, the Prokind leader made a small signal.

There were two or three seconds of hesitancy. Then "Kyyyeeee!" and boiling past his left flank a lancer dipped his splayed point and charged.

Chug froze, goggling. "Move, you fool, move!" Stuart bellowed.

Prokind and mount had formidable bulk and speed, and height with the lance aplenty enough to

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skewer Chug. They loomed at him, flayed cloth streaming, alarming and redoubtable.

Hair-raisingly late, Chug slashed the pneurifle in an arc.

The stabbed Prokind and beast collapsed in a rumbling tumble that skidded under its own momentum to thud in a kicking tangle against the base of the ship.

"Oh God!" Chug scrambled back into the air lock, smacked the button to cycle. As the door slammed shut he heard Stuart start to scream the sirens.

"I wish you hadn't done that." Stuart shook his head. "You should have dived straight into the lock." He scrubbed at his scalp with his nails. "Still, it's done now. It was provoked, if that's any consolation. I don't understand it. We're obviously from a more advanced culture, yet he had the colossal gall to initiate an attack."

"The Redskins felt much the same way about the palefaces," Senza said.

"And look where it got them," Stuart replied. "Oh yes, don't quote history at me, the barbarian hordes and the Huns. It was instinct at this stage of their evolution, I suppose, a resenting of interlopers. They'll try assault even when the logical futility of such a course would seem plain to the most ignorant."

"Yes," Senza qualified, "but *our* culture logic and *their* culture logic will not agree and they'll try to hammer it to fit *their* way, even if it kills them."

Charyl sat with her hands in her lap. "Well," and her lips bunched, "what do we do now?"

"We've made the mistake of backing down, although what else we could have done is debatable. Easy enough to frighten them half to death, but there's not much use in that unless it leads to authoritative parley. We need to be able to talk with them before we can get anywhere. I think we should prepare to leave shortly. The longer we stay, the more dangerous it's going to get."

Darkness was falling and Chug adjusted the scanners for night pickup. "They've set up a small camp down there. They'll attack us, you think?"

"Senza?"

Senza nodded. "Unless we do something to overawe them. Then, as Stu says, we're fresh out of follow-through. They'll attack to find out how we bite. We don't *want* to bite, *but,* if we don't, they'll pile on us until we're flattened."

"The ship can't take too much knocking about," Stuart said. "They light a fire round us, charge us with a tree trunk, why, even something as obsolete as a ballista could really give us a hard time. "No," he frowned, "we're loaded with data and we cannot afford to mess about in disadvantageous skirmishing. We will stand-by for

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immediate lift-off, delaying only to determine the type of offensive that they might mount—for future reference, and to have their maximum attention to be impressed by our departure. All right?"

"O.K. by me, Stu." Chug was still somewhat shaken.

"Yes, it would be." Stuart sounded just a trifle sour. "You've been out for a walk . . ."

The humans spent a wakeful, but otherwise uneventful, night. They could see that down towards the town some activity was under way, that closer some contraption or other was being constructed. Thinking themselves cloaked by darkness, Prokind spies dared to approach to within a few meters of the craft. Carefully observed, these did nothing except listen and visually examine as best they might.

With the coming of dawn, instruments aboard the craft indicated the withdrawal of all Prokind from their lurking hidey-holes to beyond the perimeter of their camp site. It looked to be a very crisp, bracing morning outside.

"They couldn't somehow have lined a cannon on us, could they?" Chug said, biting a nail. "No, O.K. no. But they're up to something."

"I'm inclined to agree," Senza said. "I don't like the way they've gone back behind the lines. Looks like they want to give themselves a clear field of fire. But they had no pistols or other items suggestive of a knowledge of explosives; there is no metal nearby of bulk sufficient for even a small cannon. They could be gathering for a charge, but . . . What that thing is that they've been making is difficult to define. It could be a crude missile launcher—harpoons, rocks—but if so, it's a weird one. And by the time they get the range we can be gone."

"Perhaps they mean to bring it nearer. Perhaps it's some kind of shield, a cover for them, maybe a wrapped battering ram, huh?"

"No," Senza said. She was perplexed. "I can't make out any sign of wheels. And anyway, it would be a rough uphill push. Enough of them could lift it bodily, perhaps. I don't know what to make of it, and that's the truth. The parts we can see of it seem to be made of some kind of stretched leather. Of course, it *could* be just a king-sized marquee tent that they've put up to serve as headquarters."

"It could be, but I don't think so," Stuart said. "The shape of it. It's too narrow for it's height. A Trojan-horse type troop container? And that thing to one side at the back, see? Blow it up. There . . . it's like an outsized accordion."

"If they weren't so patently backward," Senza mused, "I'd say they'd put together a monster vacuum cleaner, and that the open end pointing our way is to go *phwup!* and suck us in."

"It reminds me more of a

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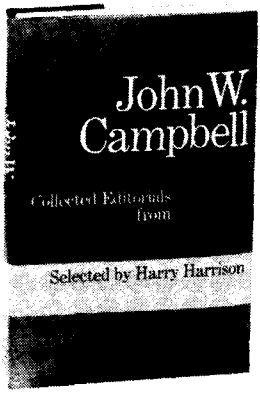

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wind tunnel," Stuart murmured.

"Well, it beats me." Senza gave up. "It could be voodoo. It could be a giant megaphone for shouting rude remarks, even. Whatever it is, it's keeping them amused and I can't see that it can do us any harm."

And in that Senza guessed right once, and wrong once.

Crrrrrrrrr. . . .

Everything before Stuart's eyes took on faintly fuzzy edges. Loose items gave off a low rapid chatter, as though noticing the cold and shivering. It took Stuart two whole seconds to realize what was happening.

"Action! Action! Crash lift! Crash lift!" His crew leaped scrabbling for harness.

They set course for home, triple-checked everything—and then checked everything again. Finally they could prepare their hibernol dosages.

"I still can't get over it," Stuart said. "Easy enough to stumble upon when you come to think about it, but how they made it work, using what they had, and for certain not understanding the principle of the thing . . ." He could only shake his head in amazement. He tapped the diagram they had made. "Infrasonics—an empirical Hertz blaster. Rough as a rasp, but effective. A few minutes would have hemorrhaged our brains into our boots.

"Chug," and he wagged a finger, "didn't I tell you, retarded as they are, that they would have thought of, or found out, a few things that we hadn't? A cowhide low-pulse generator yet. No, I won't get over that for a while . . ." ■

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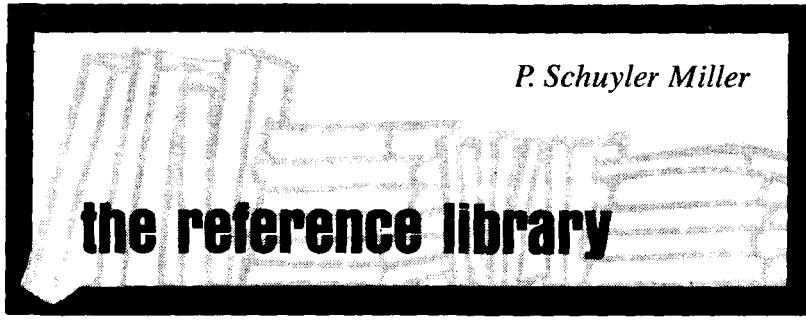

PROJECT WILDFIRE

NASA, of late, has been going through a great deal of soul-searching over the possibility of carrying lunar organisms back to Earth with Apollo 11 and future Moon landings, and letting loose plagues we can't control. The scientific community is pretty well divided on the hazards; science fiction, of course, has treated them both ways since that is one of its "things." Some say that many of our meteorites are splash from the Moon, and that if the bugs were going to kill us, they'd have been at it long ago. Others argue that lunar life, if it exists, has had billions of years to diverge from ours and would have no more effect than, say, iron-fixing bacteria do. Still others point out that in those billions of years we have had no opportunity to build biological defenses against strange microorganisms.

(Nobody is worrying about big, boisterous, bloodthirsty bug-eyed-monsters out of a Japanese monster movie; they can be killed by macroscopic means like guns and bombs and gas. It's the little fellers that can get you before you know they're there.)

At the moment, and strictly at the moment because last week they were talking the other way, NASA is running scared. They're going to quarantine the astronauts and their module. Maybe someone up there has been reading Michael Crichton's "The Andromeda Strain" (Alfred A. Knopf, New York; 1969; 295 pp.; $5.95).

This is a first novel by a graduate of or graduate student in Harvard Medical School who is

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either unnaturally talented or has read science fiction and knows what makes it tick. If his book gets into a paperback edition before voting time, it stands a good chance of winning a "Hugo" or even a "Nebula" as best SF novel of 1969. It is "hard" science fiction of the kind John Campbell made the trademark of Astounding and Analog, and I can't conceive of an Analog reader who won't enjoy it—and be scared by it.

The theme is simple and familiar. The Pentagon has been using satellites to seine the upper atmosphere for extraterrestrial organisms that may be useful in bacteriological warfare—organisms sent or wafted from the stars, organisms surviving from the earliest days of life on Earth, organisms carried up from the surface and mutated under the hail of solar and cosmic radiation. They go fishing—and they catch a piranha.

The satellite comes down in the wrong place, on the outskirts of a little desert town. Someone finds it, brings it in, and the town doctor monkeys with it. In no time, everyone in town is dead—except one drunken, sick old man and a newborn, howling baby.

Meanwhile a team of scientists have been alerted and are on their way to a buried laboratory, where "Project Wildfire" has the job of finding and isolating the organism, learning how to cope with it, and by inference how to kill other people with it. Michael Crichton knows his science, and he does an extraordinary job of weaving together the real activities of government research and the fictional developments of his story. I defy any nonspecialist to separate them —and, unlike most of the mainstream critics who have reviewed the book, I don't think his bibliography is a phony. I don't have the books and journals where I can check them, but I do know that *Science, Journal of Physical Chemistry* and *Journal of Biological Research* are not the "Necronomicon."

The book has everything. It has a good melodramatic climax when the Andromeda bug gets into the ventilating system of the Wildfire lab . . . and NASA has a nuclear bomb ready to go off if that happens. It has the quest for the bug itself, carried through step by step in practically documentary style. It has a biological puzzle that biologists may solve before the Wildfire team does—why did that old man and the baby remain alive?

It also scares me, and not because of what Apollo 11 may bring back from the Moon. It scares me because in its quiet, convincing, gently underplayed way it persuades me that government agencies already have in their files scientific and technological developments that can turn our lives inside out and upside down, and will if a future administration

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chooses to use them. Sure—science fiction has been pointing out such things for generations—but "The Andromeda Strain" makes it very, very probable that the future is here and now.

This one you'd better read. Don't wait for the paperback, either.

THE DAY OF THE DOLPHIN
By Robert Merle • Simon and Schuster, New York • 1969 • 320 pp. • $5.95

We have had many stories about man-and-dolphin partnerships since Lilly's experiments reached the press a few years ago. Some I have reported here, and Ballantine also has a paperback series about a submarine "Tarzan" which is in its third volume. This book, by a novelist of the French literary establishment, uses the dolphins as the peg on which to hang his continental distrust of the United States and its intelligence mechanism.

Dr. Henry Sevilla, a mammalogist of Spanish gypsy ancestry, is working in a Florida laboratory under a Navy—or maybe a CIA—grant. His purpose: to talk to dolphins—and he does it. Before the book is over, two of his dolphin friends, Ivan and Bessie—Fa and Bi in their own monosyllabic patois—are speaking English and Sevilla has learned the whistling dolphin language from a third. But Naval Intelligence is not interested in such academic matters, and neither is a rival intelligence agency. Both of them intend to use the dolphins—hopefully, all dolphins—as controlled weapons. No egghead with humanistic motivation is going to get in their way.

The author is clearly scared stiff of the United States. He is one of the many Europeans who believe that President Kennedy was killed by the CIA because he would not do what he was told. He believes that the CIA, the military establishment, and possibly other "invisible" agencies of the kind that pop up in every spy yarn nowadays, are the real masters of American policy and will take things into their own hands—as they do in the book—if the President and Congress don't give them a free hand. In this book they squeeze Sevilla out, take over the dolphins, and trick them into planting a nuclear mine on a U.S. warship in the Tonkin Gulf. When the ship is destroyed with all hands, and the fallout begins to come down, Red China is tagged as the culprit and a *tsunami* of public sentiment for instant and massive retaliation is whipped up. While the President ponders, Fa and Bi return, with "Agency B" at their tails, bloodily determined to wipe out any men, or dolphins, who know the truth.

As a mainline novelist, Merle uses mainline techniques in his book. The characters are individually and *en masse* a batch of grotesques—the sudden romance between Sevilla and his assistant is

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vigorous but unbelievable, and why he would tolerate neurotics like Maggie and Lisbeth around the lab is a total mystery—in the modern manner. He uses long stretches of stream-of-consciousness intermixed with conversation, without ever distinguishing between the two. This may be a subtle indication that thought and voice are inextricably interwoven, but it gets in the way. I am a bit skeptical, too, about the hideaway cottage on the rockbound cliffs of Florida, but I probably haven't seen as much of Florida as the author has.

The work with the dolphins is fine and believable. The rest is a paperback imitation of James Bond scripts.

NO TIME LIKE TOMORROW
By Ted White • Crown Publishers, New York • 1969 • 152 pp. • $3.95

Crown has been distributing hardbound editions of English SF paperbacks which are totally unreadable. With this juvenile under their own insigne they have put all that behind them. Ted White is showing himself a good naturalistic writer with a talent for bringing his people as well as his places into full perspective. Except that his hero doesn't go to bed with the sixteen-year-old heroine, as all heroes must these days, it would not be out of place on any adult shelf. I'm keeping it on mine when I put the real juveniles into storage.

Frank Marshall is snatched out

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of his back yard by an experiment that goes wrong five hundred odd years from now. He finds himself in a world in which the great conglomerates have divided up the markets of Earth and space and are feuding as viciously and formally as ever did the Renaissance lordlings of Machiavelli's time. Below the crust of Heirs and minor executive nobility, the masses of the populace are what the present literary in-group would call *drek*.

Frank is of no earthly use to the Syncom scientists who pulled him out of the past, and after finding that there is nothing to be tortured out of him, they are ready to get rid of him. At this point a rival conglomerate kidnaps him and the Syncom Heir, Dorian. They escape, they are rescued, they make their way across thousands of miles from the California coast to the Himalayas. Dorian, for the first time, sees the decay on which her own royal society is based; Frank finds there are good people everywhere.

Formula stuff? Yes—but you'll believe it.

BEST SF: 1968

Edited by Harry Harrison and Brian W. Aldiss • G. P. Putnam's Sons, New York • 1969 • 245 pp. $4.95.

This annual anthology is down a notch in my estimation from last year's. I think it's the effect of the "New Wave," which finds virtue in incoherence for confusion's sake, but there is only one story from *New Worlds* and three from English publications. Perhaps four reviews of the Kubrick-Clarke "2001" tend to water down the total effect. There is also an amusing bit of verse by venerable Astounding writer "J. J. Coupling" in his right person as Dr. J. R. Pierce of Bell Telephone Labs.

Analog is represented by Bob Shaw's "Appointment on Prila." It's not one of his slow-glass stories, but a logical puzzle yarn with a not too deeply concealed clue, much like John Campbell's classic "Who Goes There?" in its basic gimmick. And Isaac Asimov wrenches himself away from adding to the reference shelves of libraries with a beautifully tricky little short-short, "Segregationist."

Two of the lot are borderline fantasy of the kind that used to appear in *Unknown Worlds*. Robert Sheckley's "Budget Planet" is a wonderful wandering jape in which a cosmic contractor explains how he built a planet on the cheap for an "old gentleman." Of course, the budget planet is Earth. And John D. Macdonald's strange and effective "The Annex" follows the symbolic adventures of a dying man through his last hallucinations. Aldiss' own "The Serpent of Kundalini" is one of a series of stories in which the world is "really" scrambled into a temporal mosaic because of the universal dissemination of psychedelic drugs. The argument that the

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world is what it seems to be has a respectable history right here in Astounding/Analog, so we can scarcely call this fantasy.

The best stories in the book, to my taste, are totally different. Kit Reed's "Golden Acres" is by no means "bittersweet" as the editors seem to feel: it is cruel, bitter and probably accurate in its picture of an old couple dumped into a glamorized "Golden Age" resort somewhere in California—a resort where, if you are troublesome or your money has run out, the dead wagon comes to take you to the Tower of Sleep. We don't execute our old people yet—I think. Back to back with this is Mack Reynolds' "Criminal in Utopia," the wholly amoral exploits of a swindler trying to make out in a credit-card world and having his troubles. I think the ending was unnecessary.

There are some other good ones. David Masson's "Lost Ground" is another English story of scrambled time, but unlike Aldiss' it makes sense of its confusion. (Aldiss, on the other hand, creates a feeling of temporal confusion which may be precisely what he intended.) Fritz Leiber's "One Station of the Way" is a story of three wise beings on a desert world who followed a star to the scene of a not quite immaculate conception, and of the philosophical banter between the Father and his First Mate. Stephen Goldin's little "Sweet Dreams, Melissa" is really one of the best of the book, but it is so quietly unassuming in its account of the teaching of a computer that its effectiveness slips away. And Robert Silverberg's "To the Dark Star" is a parable of the inhumanity of human beings.

There remains K. M. O'Donnell's "Final War." To me, the inane confusion of the senseless, overformalized "war" of the future is overdone and merely compounds the point that war—any war—is nonsense. But who is to say that is not precisely the author's intent—to hammer the point home just as heavy-handedly as he can?

ANALOG 7

Edited by John W. Campbell • Doubleday & Co., Garden City, N.Y. • 1969 • 352 pp. • $5.95

ANALOG 6

Edited by John W. Campbell • Pocket Books, N.Y. • No. 75357 288 pp. • 75¢

By a coincidence the paperback edition of last year's annual Analog anthology showed up at the ame time as this year's new collection. Last year's had Bob Shaw's already classic "Light of Other Days" and Gordon Dickson's "Call Him Lord." The new book has nothing to match either of them, but it does have another of Shaw's slow-glass stories, "Burden of Proof," which raises the nice legal question of whether the visual memory of a slow-glass window should take precedence over the action of

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a jury and adds a barely suggested bit about the fallibility of eyewitnesses.

Correction, please: there is Anne McCaffrey's prize-winning "Dragon Search," a standout in any year and any book. It's just that this story has been reprinted so often that one tends to overlook another appearance.

You may remember some of the others if you were reading Analog regularly in 1966 and 1967. I'll take them as they come.

"Aim for the Heel," by John T. Phillifent—assassination without violence, performed on three tough customers.

"Fiesta Brava," by Mack Reynolds—who transposes Franco's Spain to another planet, literally and figuratively, then sends a remarkable set of "tourists" to help overthrow the Falangist regime.

"Free Vacation," by W. Macfarlane—in which a greenhorn and an old frontier hand team up to beat a tough world, and have the time of their lives.

"The Featherbedders," by Frank Herbert—two sets of ill-meaning extraterrestrials outsmarting each other in an imitation southern village.

"Lost Calling," by Verge Foray—the highly trained agent who forgot what his function was. Or did he?

"The Last Command," by Keith Laumer—an old soldier is the only one who can handle a faithful old war machine. This has been reprinted before, too.

"Dead End," by Mike Hodous—outsmarting the centaurs, for a really sneaky reason.

"There Is a Crooked Man," by Jack Wodhams—some of the headaches of matter transmission and its use by intelligent crooks.

"Elementary Mistake," by Poul Anderson—in which our author points out, as he has done before, that finding a solution depends a lot on how you look at your problem: in this case, a world that lacks all the necessary elements to get our boys home.

Good run-of-the-mill Analog stuff, but except for "Weyr Search" not really memorable this time round.

THE JAGGED ORBIT

By John Brunner • Ace Science Fiction Special No. 38120 • 397 pp. • 95¢

Somewhat in the manner of his grand "Stand on Zanzibar," but without quite the—successful—stylistic fireworks of that book, John Brunner is giving us an alternate view of the United States of the first quarter of the Twenty-first Century. In "Zanzibar" his theme was the overcrowding of the world two generations from now. In this book he is exploring the possibilities of the Black-and-White confrontation, and he slips only in dragging in a more or less conventional SF gimmick to resolve his

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plot. Apart from that, it's another beautiful job—intricate yet tightly constructed, thoroughly believable, with as many important characters as a Victorian classic. John Brunner just doesn't buy the artificial limitations of the "one book, one hero" concept.

The United States of the next century has split up into Black and White enclaves—some separate cities, some encapsuled within cities—which are mutually antagonistic and mutually dependent. Cosa Nostra has become thoroughly integrated and even more internationalized; it is the planet-strangling Gottschalk weapons combine, the very antithesis of Van Vogt's Weapon Shops of fond memory. The Gottschalks sell weapons of every kind and by every possible means, to nations, to cities, to organizations, to individuals—and they are merely supplying a society of corruption and violence that wants and needs their wares.

In and out of this strange fabric we follow the threads of several independent yet interdependent people. Matthew Flamen is a spoolpigeon, last of his kind in New York, descendant of our TV commentators but with a vastly more powerful technology at his disposal. Computers check the "truth" of his news—but other computers simulate what he shows as happening. His wife is in a State mental hospital where other strange things are happening. There is one very strange black technician. There is a visit from a pythoness—a seer—whose visions are far from cryptic. There is Diablo, Flamen's black counterpart, hounded out of Blackbury and seeking a refuge in the White community he hates. There is Xavier Conroy, the book's philosopher-in-residence and perhaps spokesman, or devil's advocate, for the author—another good Victorian technique that he uses effectively. There are many more. Glimpsing them, watching them, following them we see their world and watch the crisis building, even though we have no idea what is really happening.

And then— Well, that's something to find out for yourself. Read Conroy's blast on pages 337 to 340, look around you, and then buy the book and read the rest.

THE FORTEC CONSPIRACY
By Richard M. Garvin & Edmond G. Addeo • Signet Books, N.Y. • No. T3832 • 160 pp. • 75¢

I missed the hardcover edition of this book last year. At least, my bookstore never managed to get it before the paperback came out. It's a good save-the-world thriller with a stronger science-fiction element and a good deal more verisimilitude than usual.

Dr. Barney Russum, electronics engineer, has been told that his brother in the U.S. Air Force has committed suicide. It's a closed-casket funeral, and Barney's back

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begins to bristle. He senses a cover-up in Fortec, the Foreign Technology wing of the Air Force in which his brother worked. He finds that others in the crew of a plane that went to Norway to investigate a flying-saucer report have died or vanished. He gets his hands in some very strange tissue analyses—tissues with no carbon content.

Naturally, he blunders in to find out what is going on. He even raids Wright-Patterson Field.

The book is a thriller-oriented bush-league variant on the theme that has been turned into a major SF novel in "The Andromeda Strain"—extraterrestrial disease loose on Earth. It will probably make a better low-budget movie.

Reprinted Fact and Fancy

EDGAR RICE BURROUGHS: MASTER OF ADVENTURE
By Richard A. Lupoff • Ace Books, N.Y. • No. N-6 • 315 pp. • 95¢

More a biography of Burroughs' books than an analysis of the creator of John Carter, Carson Napier and Tarzan. I understand that one is being written by someone else.

IS ANYONE THERE?
By Isaac Asimov • Ace Books, New York • No. N-4 • 319 pp. • 95¢

The richest lode of Asimovian miscellany we have had in a long time—from the chemistry of insanity to science fiction (the insanity of chemistry?) via the stars, the seas, the future, our innards: you name it.

THE SECOND BOOK OF THE COSMIC FORCES OF MU
By James Churchward • Paperback Library, New York • No. 54-754 • 22¢ pp. • 75¢

I'd never seen the hardback edition of Churchward's "Cosmic Forces," in which he gave his Mu-oriented views of physics, et al. Consequently, I didn't realize Paperback was splitting the book up into pieces. If you really want to know what the Mu-myth is all about, there's no easier way to find out than by reading, or trying to read, these paperback editions. Unless, of course, your neighborhood occultists conned the public library into putting the originals in its reference department.

NEW LANDS
By Charles Fort • Ace Star Books No. H-74 • 222 pp. • 60¢

WILD TALENTS
By Charles Fort • Ace Star Books No. H-88 • 222 pp. • 60¢

Churchward apparently conned himself into believing his stuff. Fort collected outrageous data with tongue in cheek, and drew outrageous conclusions from the "facts." You'll find these, and the

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earlier books—"Book of the Damned" (K-156) and "Lo!" (K-217)—a lot more fun than Mu.

THE CRYSTAL WORLD

By J. G. Ballard • Berkley Books, New York • No. X1380 • 160 pp. • 60¢

Paperback of Ballard's latest and perhaps his strangest novel, but not his best.

THE GOLDEN APPLES OF THE SUN

By Ray Bradbury • Bantam Books, New York • No. H-3357 • 169 pp. • 60¢

Reissue of the 1954 paperback of the 1953 short story collection: mixed SF, fantasy and "straight" fiction.

THE RAGGED EDGE

By John Christopher • Signet Books, New York • No. P-3124 • 192 pp. • 60¢

Pb of Christopher's last catastrophe yarn, and one of his better ones: the sea drains away, leaving England and the Channel Isles high and dry.

THE WORLD JONES MADE

By Philip K. Dick • Ace Books, New York • No. F-429 • 192 pp. • 40¢

Reissue of one of the author's earliest paperbacks (1956), and one of his best stories: about Jones, the would-be dictator who can see a year ahead.

With a magazine like Analog, you would, of course, expect us to use computers for handling subscriptions.

The trouble is—computers are very, very stupid. They need to be told EXACTLY what you want, in every detail. Or they get neurotic, and you don't get magazines. (Neurotic computers are known to have spit miles of tape, and thousands of punched cards all over the room before they could be shut down.)

So . . . if you want your magazine to follow you when you move, you've got to do it the Computer Way.

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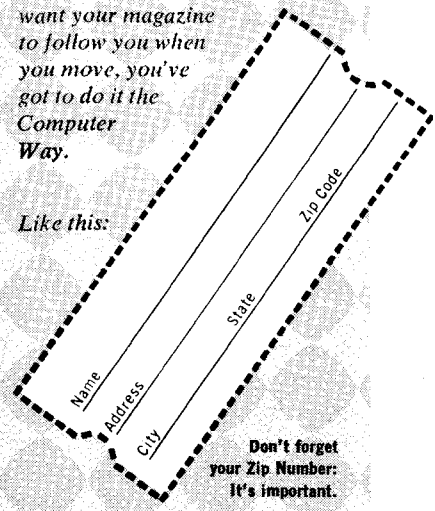

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brass tacks

Dear John:

Part One of the article in the March, 1969 issue entitled "They're Trying To Tell Us Something" has prompted me to drop you a line within a couple of days after receiving the issue.

Although tentative conclusions may well be issued in the Part Two of the article, it seems to me that a possible conclusion is rather obvious.

If I were building a series of navigation buoys, and wanted to insure that the information was received as easily as possible when close to the buoys to make it meaningful, and yet was not interested in jamming the spectrum with information which was not useful when too far away, I would: 1) Select a frequency spectrum that was quite noisy and, therefore, relatively useless for sophisticated communications. 2) Generate information pulses which could be picked up on a wide range of different types of receivers. 3) Have a very high local field intensity, but have a high attenuation factor so that travelers who were far enough away that it was unimportant would not receive the information. 4) Generate very simplified coded information which would provide basic information on coordinates, navigation problems, and in more sophisticated versions, a repeater recorder system for allowing "drop offs" of messages to be picked up by later travelers.

In examining the spherical coordinates of the pulsars, it occurred to me that if these were plotted out on a true spherical system, there might be some interesting indications on possible interstellar routes.

DENNIS WILLARD
11847 Teale St.,
Culver City, California 90230

Trouble is, interstellar travel at sub-light speed—the only way you could detect the pulsars—takes soooo long! Our little green men must have life-spans that make Methuselah a babe in arms!

Dear Mr. Campbell:

I am, presently, a high school senior, and plan to major in Electronics Engineering—but also with a minor in Semantics. Last summer I had the good fortune to partici-

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pate in one of the National Science Foundation's Summer Science programs, and was introduced to the use of computers in the form of an IBM 360 on a time-sharing basis. Needless to say, I and my fellow scholars (?) managed to run up an amazing amount of time on said machine by having it do such earth-shakingly important things as print out Pi to "X" places. However, the main effect of the program was to thoroughly convince us that we could no longer live a full life without a computer terminal nearby.

At roughly the same time, the principal of the high school I attend was thoroughly taken with the glowing reports of our collective efforts. So much so that he completed spending almost $6,000 (yup, six thousand) in supplies and on the rental of a unit records system . . . no memory, no computer—just the input and output of one! So, the thing—nicknamed, of course, the Iron Monster—is thoroughly botching up the job for which it was intended. It does, however, do an impressively good job of keeping up with pupil Joe Whosis as he cuts his next class.

Somewhere in the vast readership of Analog there *must* (please?) be someone who can tell me where to go or whom to talk to to get my hands on one of those old, hulking, technically obsolete computers that were in vogue about ten—or even five?—years ago, like the Bendix G-15. I would be willing to give a darned good try at paying whatever the machine is worth, although it will probably keep me on my toes for a *long* while. Maybe, if Lady Luck sees this (or better, a tax-deduction-minded businessman . . .) I can get a few replies.

ROBERT J. MARTIN, IV
525 First Avenue NW
Hickory, North Carolina

Old computers never die—They just fade away?

Dear Mr. Campbell:

In your December issue, the conjunction of Joseph Goodavage's "Situation of Some Gravity" and your Kipling quotation in response to Mark Swanson's letter leads me to wonder how many of your readers know just how far ahead of us Kipling kept his own "light so shining."

Among his many short stories in the science-fiction/fantasy realm, only two seem at all remembered: "With the Night Mail" and "As Simple As ABC." But in "Unprofessional" he envisioned, decades ago, precisely the sort of intensive biomedical research on astrological forces that Goodavage now reports; even his title is a lovely reflection of the opening paragraph of your own introduction to Goodavage's article.

And in "A Doctor of Medicine," Kipling gave us one of the world's

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more charming reconciliations of astrology-as-nonsense and astrology-as-fact. Put the two tales together, and you see a mind that wouldn't be surprised by anything science does—or that upper-case Science may refuse to do—about astrology, now or ever.

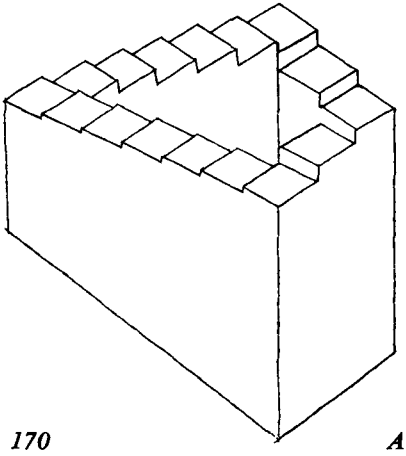
For your bibliophiles, "Unprofessional" is to be found in the book "Limits and Renewals;" "A Doctor of Medicine" in "Rewards and Fairies." And your quotation is from "The Mary Gloster;" Kipling was very careful about his references.

JOHN F. STEARNS
4600 S. Four Mile Run Drive,
Arlington, Virginia 22204

Two of those I hadn't run across myself!

Dear Mr. Campbell:

Re your "Sensational Discovery" editorial: Here is a visual analog of the pitch phenomena. The descent



appears to be unending and never seems to get to the base of the construction—lower visual limit. You can "see" that at almost any stop at which you halt in a descent, the diagonally opposite step can appear to be higher. (The reverse also exists if you ascend the stair-visually.)

MORRIS L. GRODER
182-25 Wexford Terrace
Jamaica Estates, N.Y. 11432

An excellent visual paradox analogy!

Dear Mr. Campbell:

Perhaps there is a way to destroy an infinite number of alternate universes in a finite time. For an analogy, take a ball which rebounds to half of the height from which it fell. If dropped 5 meters, it travels a total distance of 15 meters in an infinite number of bounces. But on earth, the ball completes its (theoretically) infinite series in about 6 seconds! (The equation is $1 + .707 + .707 + .5 + .5 + .35 + \ldots$ if $g = 10$ m/sec/sec.)

So, if each time the ball bounced, a universe was destroyed, the aliens would finish their job rather quickly, unless the infinity of universes is larger than the infinity of integers.

But there is another obstacle to the universe-destroyers: the infinite number of benevolent races out there! Since they are friendly, they have no doubt united and are

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stronger than the fragmented "paranoids". And we are safe, protected by the Paratime Police!

MARK ZIMMERMANN
6812 Langston Dr.,
Austin, Texas 78723

Hm-m—seems to make some sense!

Dear Mr. Campbell:

Your editorial, as usual, was interesting and your observations about the face-saving technique of the Orientals has an all too true ring to it. The Orientals have developed this "We'll wait for the enemy to accept our demands, or force them to give up theirs through impatience," attitude to an astonishingly successful degree. Unfortunately, the bureaucrats never seem to recognize—or don't pay any attention to—this viewpoint.

The short story by Perry A. Chapdelaine, "Initial Contact," was a good follow-up of the science fact article on pulsars by Thomas R. McDonough.

Mr. Chapdelaine shows how human emotions can easily embroil any situation. I wonder . . . *Are* they trying to tell us something?

MIKE SUTTER
St. Ambrose College
Davenport, Iowa

This time it's not the bureaucrats who fail to understand—it's "We, the people"! And what can a politician do when the people are ignorant, wrong, and insistent?

Dear Mr. Campbell:

I was amused by your counter-intelligence alphabet. I have used a few examples myself in the past. I'll leave it to you to decide if any of mine should be adopted. I hope that you will at some future date publish a complete, solid list. I say solid because a few you listed are weak, or are terrible words in their own right, e.g. Urn, Bdellium, Ctenoid.

My recommendations are:

E: Europe, Eulalia (my good wife's name).

P: Psalm, Pneumatic

Q: Qatar (usually said by non-Arabs as "gutter")

X: Xhosa (M. Mikebo's Language—the XH stands for a click).

G: Gnat

N: Ngaio (as in the author's name, Susan Ngaio; not in the OED alas).

Upon reading my list over I find that some of mine are as wild as the ones I was critical of, so I don't feel I should criticize bdellium, et cetera.

I enjoy your magazine very much, both for the articles and your editorials which I usually agree with. May I seriously suggest that you increase the number of issues a year? I will accept as reasons for turning it down that there is not enough material, or the work is too much. Maybe you can increase the number of pages? Would adding 16 or 32 pages be

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easy? To sum it up, I like it so much I want more!

VINCENT J. MOONEY, JR.
665 A Hathaway Road
Vancouver, Wash. 98661

"Xhosa" (also spelled "X'osa") is a fine addition; "Ngaio" is borderline, since it's a personal name, rather than a word. The best confusers should be very unfamiliar words; "psalm" is much too common, as is "gnat." Most people haven't the foggiest idea what a "gnomen" is, though.

Dear Mr. Campbell:

I had a good chuckle over Mrs. Kennedy's "Analog Counterintelligence Alphabet." You might be interested in an alphabet which I concocted several years ago, and which appeared in *QST* Magazine, November 1958, page 172.

Its purpose was a little different than Mrs. Kennedy's; it was intended as a sarcastic comment on the then-rather-new ICAO phonetic alphabet (Alfa, Bravo, Charlie . . .). Nevertheless, you may find some of the words appropriate:

A—Archipelago
B—Brachycephalic
C—Czechoslovakia
D—Djibouti
E—Either*
F—Fortuitous
G—Gnu
H—Hyoscine
I—Ichthyophagous
J—Jeopardy
K—Kodiak
L—Ljubljana
M—Mnemonic
N—Nebuchadnezzar
O—Otorhinolaryngologist
P—Pterodactyl
Q—Quebec**
R—Rhododendron
S—Sjambok
T—Tzigane
U—Uxorious
V—Vladivostok
W—Wladziu***
X—Xylophone
Y—Ypsilanti
Z—Zodiac

*pronounced "eye-ther".
**pronounced "kay-bec".
***pronounced approximately "vwaju". This is a Polish proper name.

You may note that the word listed for Q is the same, and pronounced the same, as in the ICAO alphabet. I thought at the time—and still think—that there is no way to foul this one up any worse.

JIM LOMASNEY
2501 Waverley Street,
Palo Alto, California, 94301

If I could pronounce that "W" there, it might be used in the Kennedy alphabet. It doesn't sound like "W"!

Dear John:

Paul Blass's point, and yours, about "slow glass" in the April Analog's letter column is well taken, but there is a factor which

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neither of you, nor Sprague back in the "Johnny Black" days, seems to have considered.

At the interface between two media of differing energy-transmission characteristics one collides with a phenomenon which the electronics bugs call "impedance matching." In optics it shows up as a function connecting index of refraction and percentage reflection.

Mr. Blass may be right in saying that the square meter of slow glass left in sunlight for a year would be *exposed to* around 10^{10} calories—I haven't bothered to check, but the number seems about right. Unfortunately, it would *absorb* less than one of them, (making a guess at the index of refraction involved—I don't remember the time factors vs. thickness in Shaw's stories). Essentially all the radiation would be reflected. Sprague's towel bar and Bob's window panes would be about the shiniest pieces of glass ever seen from the outside,

HARRY C. STUBBS

An anti-resflection coating, perhaps? And at exactly normal incidence?

Dear Mr. Campbell:

In "They're Trying to Tell Us Something" (Part 2), Mr. McDonough states: A neutron star is what may be left after a star explodes. A star that explodes would be a super-nova, would it not? I believe *implodes* would be a better word so as not to be confused with a super-nova.

GERALD N. BLAIS
728 Adams
Port Townsend, Washington 98363

A supernova blasts some ninety percent of its mass off into space; it explodes but good! The remaining ten percent, driven inward as the rest was hurled out, is the neutron-star remnant.

Dear Mr. Campbell:

My lifelong tendency toward undisciplined reading has produced a question I hope you can answer. Why, when history shows the most effective first wave of pioneers usually comes from the malcontent and misfit factions, are the ranks of the astronauts/cosmonauts almost exclusively composed of their exact opposite types? At least, all I've ever heard of were highly educated, well adjusted, and quite willing to go after whatever goal they desired via the proper channels. What happened to all the "nuts" we used to make such a fuss over?

WALTER C. SMITH
South Road
Harwinton, Connecticut 06790

You're looking in the wrong place! The pioneers were nuts, crackpots, misfits—like Oberth, Goddard, and Von Braun—who first proved rocket ships could be built!

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EDITORIAL

continued from page 7

technitium nor rhenium was found before 1925, and the quantity of rhenium was so minute that thorough studies were almost impossible. The family characteristics of the Group VII-B elements couldn't be determined properly . . .

That area has now been cleared up; there's enough technitium accumulated from fission products to make a very fair supply for chemical research. It's available at about ninety dollars a gram in metallic form. Rhenium is now produced commercially from various flue dusts; it sells for about two dollars a gram in powder form, or eight hundred to fifteen hundred in strip form. It's a wee bit hard to convert from powder to solid metal; rhenium is second only to tungsten in melting point—it's still solid at 3100 ° C; its relationship to the platinum metals corresponds to that of manganese to the iron-nickel-cobalt group. It has a density of 21, and makes some highly useful alloys with tungsten. But at its price and natural rarity, it isn't of wide application.

Those changes over the past forty years or so are largely due to special problems, or theoretical advances. However, what's happened to the periodic table of elements is almost as remarkable as what's happened to organic chemistry, nuclear physics and astronomy.

When our Class of '25 chemical engineers left school, there were a lot of squares in the periodic table chart with neatly lettered names, atomic weights and numbers, and perhaps a sample stored in some University museum somewhere. Things like zirconium and europium and gallium.

In 1925, in the Group IV elements, there were three of engineering importance—carbon, tin and lead. Of course silicon, as silicon dioxide and various complex silicate rocks was important, and silicon carbide was an excellent abrasive—but what else could you do with the stuff? The other squares under Group IV contained odd names like zirconium, titanium, hafnium and thorium—and aside from the fact that thorium oxide was useful in gas mantles, that was about it.

Of course the first explosive development in the Group IV elements came about when the transistor was developed—it turned out that germanium and silicon were the most practical sources of usable semiconductor materials.

The Atomic Energy Commission has been interested in zirconium for some time; zirconium is not a rare element—it was just an unexploited element heretofore. The metal is very similar in density, appearance, and general feel to

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high-quality stainless steel—but unlike stainless, it doesn't corrode in chloride solutions. And the zirconium nucleus does not absorb neutrons—which hugely interested the AEC. It makes an ideal material for cladding reactor fuel elements, and for structural members in nuclear reactors. The chemical engineer likes the stuff because of its extremely good corrosion resistance; even at about five dollars a pound it paid off for him.

But zirconium has one joker; that other Group IV element, hafnium, that no one had paid any attention to. Rhenium was the last of the stable elements discovered—but it held out only by rarity. Hafnium isn't rare, but its chemical properties are almost identical to those of zirconium—so much so that it had been masked by its more plentiful twin. And unlike the *chemically* near-identical zirconium, hafnium soaks up neutrons greedily.

The ion-exchange techniques that worked well on rare earth elements will also work in separating Zr from Hf—but they do add to the cost. Reactor grade Zr is about 99.999 +% pure Zr, but it is *not* sold at $5 a pound. The extracted hafnium can be used for reactor control rods, of course.

However it appears in another form. In 1925, everyone knew that tungsten remained solid at a higher temperature than any other element—up to 3400°C. a temperature so high that nearly all chemical bonds break down. Since compounds break, and no element has a higher fusion temperature, clearly nothing could exist that had a higher melting point, for all the elements were known . . .

Hafnium carbide has a melting point high enough so that the compound can float around like a sort of iceberg in a sea of molten tungsten. Moreover, it forms a sort of quasi-compound with tantalum carbide that has an even higher melting point, somewhere above 3900.° Exact temperatures are a bit hard to measure when you get up in that region. And the two carbides do *not* break down at that temperature; alas for the theory about compounds!

Titanium, the other member of Group IV that was of no practical use as of 1925 is currently being mined and processed in enormous tonnages. Fortunately there's no danger of running out of the stuff—it's one of Earth's most common elements. No, it is *not* being used in such quantities as a metal—but our chemical engineer of 1925 may well have been working on it as the dioxide. It's the whitest white pigment known; just a little tricky to manipulate, but so markedly superior that it's well worth the tricks.

The metal itself, of course, is used in supersonic planes because it can stand heat, is tough, strong, and noncorroding, and is lighter

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than stainless steel. The metallurgists have problems with titanium metal, too—it's got tricks that are anything but helpful. Take a nicely rolled flat sheet of titanium, and slit it into thin strips; the strips cut from the nice straight, flat sheet proceed to roll, curl, twist, and act like a dying snake. Before the tricks of the metal were learned, it ruined tools, drove machinists nuts, and terrorized metallurgists. If you think nitrogen is an inert gas—you just don't know how it reacts to titanium. Titanium reacts more violently in nitrogen than in pure oxygen! (It also burns nicely in pure carbon dioxide, water, or all other standard extinguishing materials.)

Titanium's excellent mechanical and chemical properties—it's extremely resistant to corrosion, and a lot is used by chemical industry for corrosion-proof equipment—remained unknown and unusable until the late '30s, when processes for getting high-purity, gas-free metal became available. Zirconium, hafnium, titanium and a number of other active metals, such as vanadium, have a tremendous ability to absorb gases—hydrogen, nitrogen, oxygen, even some of the "inert" gases—into the solid metal. And the metal is thereby rendered brittle as glass. Ductile vanadium was not available until 1950, although ferro-alloys had been used for years.

In 1925 there were a lot of other names-in-squares that didn't mean anything in engineering terms. Things like selenium, tellurium, gallium, indium and niobium. Of course the rare-earth elements were just curiosities, not useful for anything except for "misch metal," a mixture of the earth metals smelted to the metallic state and becoming popular as cigarette lighter "flints." Who needs neodymium, europium, and the rest of that bunch?

Currently there's quite a market for europium, as you know—it's the necessary impurity in the fluorescent crystals of your color TV set that produce a good, strong, bright red. In 1925 TV wasn't even "just around the corner" yet.

And lasers weren't even a vague hunch in some way-out theoretician's mind. So the potential of neodymium doped laser crystals couldn't have been imagined.

Nor could the possibilities of things like gallium arsenide solid-state lasers, cadmium selenide photocells, photoresistors, and the various selenide and telluride infrared detectors.

As far back as the '20s, metallic sodium had been used for conducting very heavy currents over relatively short spans by running the molten metal into cast-iron pipes, and sealing the piping against air and water vapor. But the demand for immense quantities of electric power hadn't really started then—and the copper shortage

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wasn't more than hinted at. We're now headed into an era when the conductors for power lines may not be familiar copper and aluminum—or even the newer sodium-filled polyvinyl plastic pipes. They may turn out to be related to the present superconductor magnet windings—niobium-tin intermetallic compounds. As the demand for power rises, and the supply of copper diminishes, the superconductive cables look more and more practicable, even if liquid-hydrogen temperatures are required.

I've left out the changes in organic chemistry—the organic chemical engineering that's exploded in the direction of plastics, of biochemicals such as antibiotics that are produced by fermentation, the immense growth of petro chemistry. You can't cover everything in one editorial!

There are still a number of unused "squares in the table"; some time we may find that scandium is *the* element needed for *that* job. Indium, for example, doesn't yet have any mass application—but it's magnificent for soldering at very low temperatures. Indium itself melts at about 150°C., various alloys melt even lower, and it's the "wettest" of all metals—i.e., it will wet almost all other metals. Mercury wets gold, silver, copper and zinc, a wide variety of metals—but it won't wet iron, for example. Indium wets germanium and silicon; it makes a great transistor solder!

Indium also has a terrific neutron absorption ability—which makes indium foils important in nuclear work. It's a cognate of aluminum in Group III-A, along with gallium and thallium. Thallium is still one of those "squares in the table"; the only present use is as a poison for killing rats and ants.

Wonder what they'll be using it for when the Chemical Engineering Class of '70 is ready to retire about 2015 AD?

Incidentally, the abundance of these elements is *not* easily determined. For a long time, it was thought that rubidium was a relatively rare element—but it's now known to be considerably more common than chromium, zinc, or copper. It's just so much like potassium in its behavior, and so easily overlooked, that its plenitude isn't realized.

Selenium seemed relatively rare—until people started looking, when a peculiar pattern manifested itself. It *is* rare in most of the world—in fact practically all the world supply of the stuff seems to be in North America! Here, cattle and other grazing animals are sometimes poisoned by eating plants that have grown in sulfur-poor, selenium-rich soil, producing a form of "loco weed" that's deadly. Sulfur is necessary for growth of living cells in animals; selenium

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is a cognate of sulfur in Group VI-A, and metabolism tries to substitute the S_e for S.

It almost works. That's why it produces monsters.

Yet in Australia and New Zealand, they've discovered recently, "milky white disease" of sheep—a serious economic problem—is caused by lack of selenium in the soil! The animal's muscles degenerate, and the muscle tissue turns milky white—hence the name. The condition is reversible and preventable by simply spraying selenium compounds on the pasture land.

When astrophysicists try to estimate element abundance in the Universe, they're somewhat like a geologist, confined to studying one small island, trying to judge the composition of the planet. Evidently the relative abundance of elements varies wildly in different areas of Earth—and gradually astrophysicists are learning that different stars—the furnaces where atoms are "seasoned to taste and cooked until done"—have different recipes for atom-cooking.

There is no technitium in the Sun so far as we can see, and none in Earth—even the 2.6 megayear isotope has run down since Earth was formed. But there are many stars which show a strong spectrum of technitium; evidently those stars are busily cooking it up in quantity . . . while Sol does not.

Other stars are known to show, in their spectra, strong lines of platinum and the platinum metals; they may have *very* interesting planets! Other stars have wildly different brews of atoms, with relatively far higher proportions of elements that are barely detectable or apparently absent in Sol, and rare on Earth.

One thing we can say for sure; we do *not* know what the relative abundance of the elements in the Universe is. It isn't easy to account for the fact that iron, nickel and cobalt, all very near the least-energy dip of the packing fraction curve, and, therefore, representing the most stable possible nuclei, should have such wildly different abundance. Iron's everywhere in Earth; cobalt's relatively rare, and nickel isn't too common.

Our theories of nucleogenesis leave something to be desired—and from the startling variations in what the different "peculiar" class stars seem to be cooking up, there seems to be a large element of pure whimsy in the chemical table! There are so many, and such variable, types of stars with high abundances of unexpected elements like rhenium or platinum or technitium that a class name was developed—Peculiar is their official designation.

One thing appears certain about Out There.

We'll be surprised. ■

The Editor.

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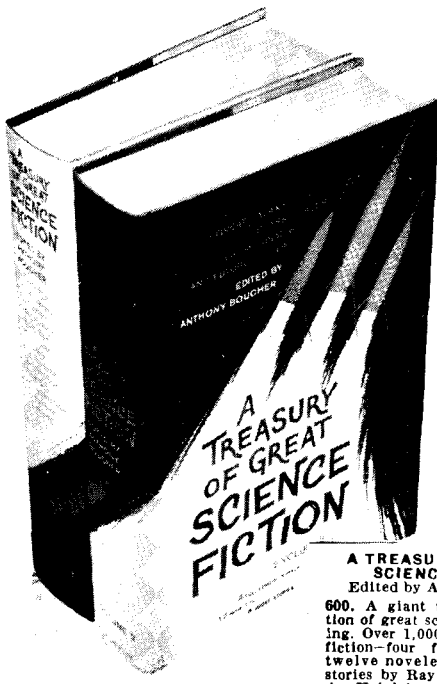

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